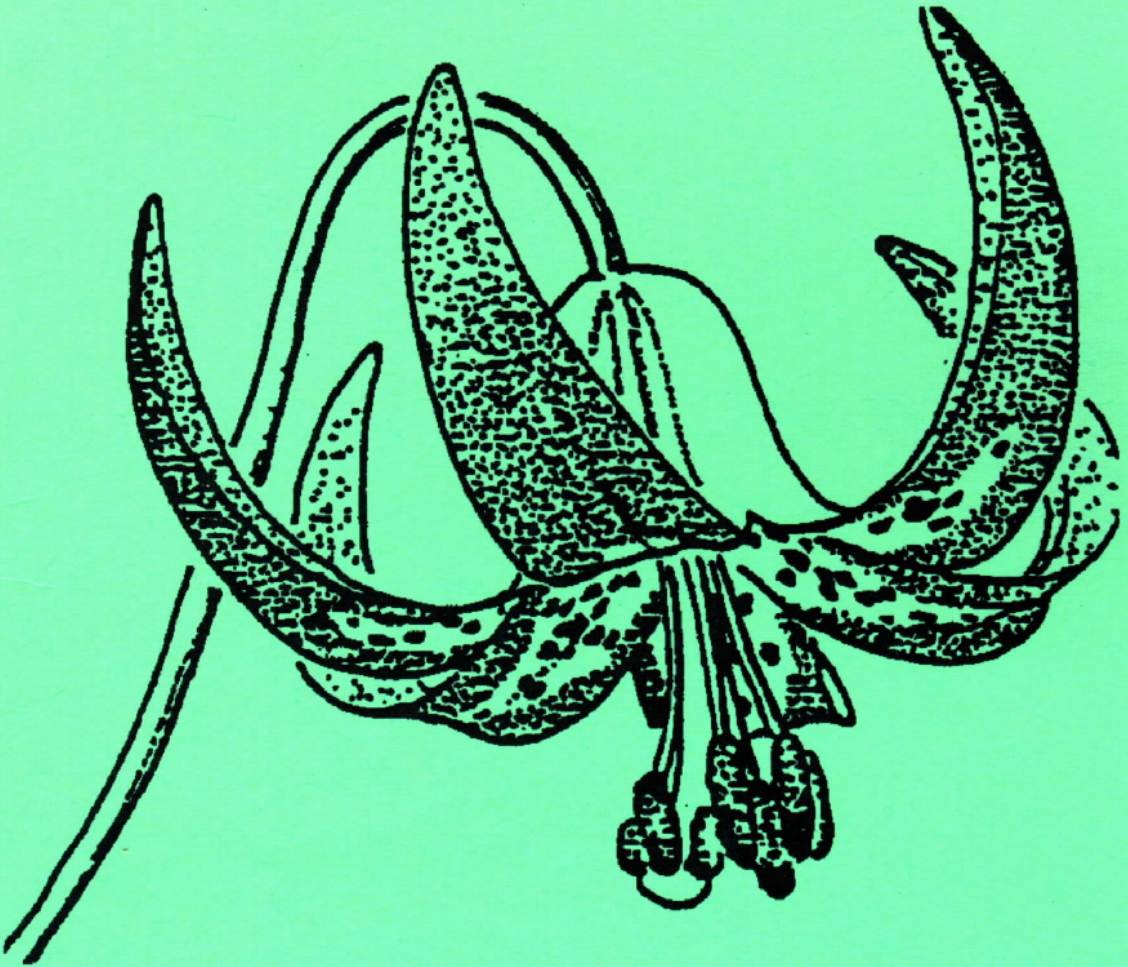
U.S. Fish and Wildlife Service

# Final Recovery Plan

## *For the Endangered Western Lily (Lilum occidentale)*



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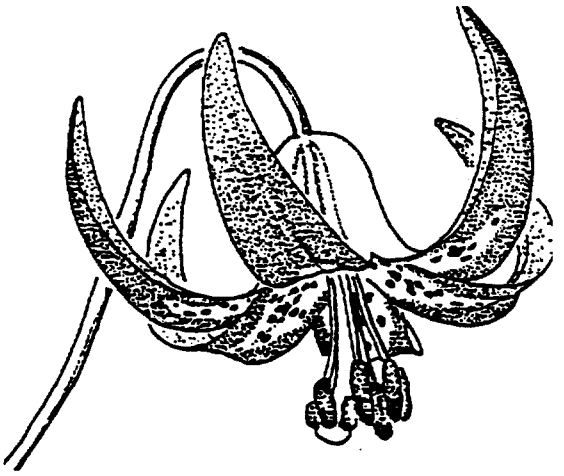
# Recovery Plan for the Endangered Western lily (*Lilium occidentale*)



Prepared for
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Date: 3/31/98

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**Literature citation:** U.S. Fish and Wildlife Service. 1998. Recovery Plan for the Endangered Western lily ( *Lilium occidentale*). Portland, Oregon. 82 pp.

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## EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR WESTERN LILY

**Current Status:** The western lily was listed as endangered without critical habitat on August 7, 1994. The species occurs in a narrow band along 320 kilometers (200 miles) of the Pacific coast from near Coos Bay, Oregon southward to near Eureka, California. Approximately one third of the historically known populations appear to have been extirpated, and three-quarters of the extant populations consist of 100 or fewer individuals.

**Habitat Requirements, and Threats:** The western lily occurs in early successional bogs or coastal scrub on poorly drained soils, usually those underlain by an iron pan or poorly permeable clay layer. Populations are found at low elevations, from almost sea level to about 100 meters (300 ft.) in elevation, and from ocean-facing bluffs to about 6 kilometers (4 miles) inland. The primary threats to the western lily are: (1) human modification or destruction of habitat; (2) competitive exclusion during natural secondary succession; and (3) grazing by deer, livestock, elk, and small mammals. Secondary threats are: (1) human depredation; (2) insect herbivory; (3) fungal, viral, or bacterial infection; and potentially (4) random loss of genetic variability in small populations. Site-specific recommendations are provided.

**Recovery Objective:** Downlisting to threatened.

**Recovery Criteria:** The western lily can be downlisted to threatened when at least 20 viable populations are protected and managed to assure their continued existence. The 20 populations must be distributed among 6 recovery areas, roughly in proportion to their original relative abundances. For the purposes of this plan, a viable population includes at least 1,000 flowering plants, and a population structure indicating stable or increasing plant numbers.

**Actions Needed:**

1. On-site conservation that manages habitats to maintain habitat in appropriate seral stage (i.e., prevents or reverses encroachment by trees and shrubs).
2. Establish seed bank and learn how to reintroduce or augment populations in the wild.
3. Enhance public awareness, understanding, and participation in western lily recovery.

**Total Estimated Cost of Recovery ($1,000's)**

| Need 1 | Need 2 | Need 3 | Total |
|---|---|---|---|
| 1,298 | 30 | 50 | 1,378 |

**Date of Recovery:**

Downlisting to Threatened status should be initiated in 2006, if recovery criteria are met.

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# I. INTRODUCTION

## Overview

With a characteristic "golden star" at the center of its pendant crimson flowers, and stamens directed straight down in a narrow cylinder, the western lily (*Lilium occidentale*, Liliaceae) is a distinctive and spectacular species in a genus known for its striking beauty and horticultural appeal. The range of the western lily is very limited, and its habitat and ecosystem processes have been dramatically altered this century.

The status of the endangered western lily has been recognized since the report by the Smithsonian Institution that was commissioned by Congress for the Endangered Species Act of 1973 (The report, dated January 1975, was printed as House Document No. 94-51. Ayensu and DeFillips [1978] is a revised version). Two status reports subsequently documented threats to the western lily (Siddall and Chambers 1978, Schultz 1989). It is state listed as endangered in both states where it occurs, California (Skinner & Pavlik 1994) and Oregon (Oregon Administrative Rules 603, Division 73).

Western lily was listed as endangered by the U.S. Fish and Wildlife Service on August 17, 1994 (59 FR 42171). No critical habitat was designated because it would necessitate revealing the precise location of populations, which could increase human depredation and further endanger the species.

## Description of species

Western lily is an herbaceous perennial flowering plant. Seedlings and small juveniles produce a single above-ground leaf. Larger juveniles and reproductive individuals produce a leafy shoot to 2.5 meters (8 feet) tall. It grows from an unbranched, scaly, bulblike rhizome, the longest scales of which are 1-2.5 centimeters (0.4-1 inches) long, each with 1-2 (or 3) segments. Rhizomes (commonly called bulbs) may produce one or more flowering shoots per year, each typically with 1-3 but up to 25 pendant flowers. Capsular fruits become erect and may produce over 100 seeds when mature. Leaves are

distributed singly or in 1-9 whorls along the shoot, and are more or less linear, 4-19 centimeters (1.6 - 7.5 inches) long, with straight, not wavy margins.

Flowers are more or less widely bell shaped with six tepals (look alike petals/sepals) 3-4 centimeters (1-1.6 inches) long, that are strongly curved back for half or more of their length when mature. The distal (upper) half or more of the six tepals is crimson to deep maroon in color (rarely orange), and the basal half yellow to green, sometimes with a yellow or orange band in between. The basal half to two-thirds of the tepals may have maroon spots. The flowers are strongly green outside on the basal half, and crimson on the upper half. When viewed from their open end, western lily flowers give the appearance of a golden star because the yellow basal portion comes to a point toward the midline of each tepal. The stamens and style remain nearly straight, whereas in all other orange or red flowered lilies, the stamens and usually style curve outward, often over 1-2 centimeters (0.4-0.8 inch) from the centerline of the flower.

The western lily can be recognized by the deep reddish outer (distal) perianth that contrasts with the yellow, yellow-green or entirely green inner (basal) perianth. In *Lilium pardinalum*, the inner perianth is orange (or yellow or yellow-green) and the outer is orange-red. This other species does not present the "golden star" appearance because the lighter colored basal portion is more irregularly distributed than in western lily. Flowers of the much more common *Lilium columbianum* are commonly pure orange. For more details see Schultz (1989) and Skinner (1993). There may be hybridization between *L. occidentale* and *L. columbianum* at the Morrison Road site (p. 60)

**Distribution of species**

The earliest known western lily collections were made in the late 1800's by Carl Purdy, from around Humboldt Bay, California (Purdy 1897). Not until 1913 were any collections made in Oregon, when Morton Peck found the western lily near Brookings.

Today, the western lily is known only from widely scattered sites within about 6 kilometers (4 miles) from the Pacific Ocean along 320 kilometers (200 miles) of the coast from near Coos Bay in Oregon, south to Humboldt Bay in California (Figure 1, map).

Older herbarium specimens collected by Jepson at "Quarts Creek & Camp six," Mason at "Pitkin Marsh & Trinidad Head," and Tracy at "Flint Valley and Elk Valley" appear to have been misidentified (Schultz 1989) and are not mapped in Figure 1 or included in Table 1.

The western lily has been reported from approximately 55 sites, nearly a third of which (18) appear to have been extirpated. Of the remaining 37 reported sites, 9 have not been surveyed recently and thus it is unknown if plants are still present. Of the remaining 28 sites, only four have as many as 1,000 individuals, three have between 100 and 300, and 21 have 100 or fewer, with seven of those having 10 or fewer individuals (Table 1).

The term "site" is used to mean the occurrence of one or more plants at a defined geographical location. A named site may straddle two adjacent public land survey sections. Named sites are used simply to track the known occurrences of western lily plants, and no claims are made as to what constitutes a biological population (i.e., a group of plants among which genetic communication is sufficient to offset divergence among its component parts due to differential natural selection or random genetic drift). In Figure 1, each dot indicates an occupied section and those sites that straddle two sections get two dots. However, if more than one named entity occurs within the section, only one is given a dot. The term "population" is also used throughout this recovery plan. It is intended to mean either or both: (1) a population in the common sense meaning of the term—all western lily plants in a local area, discrete from other such groups and (2) all plants in the same management area. Neither of these definitions are intended to imply that the group of plants is necessarily a population in the strict biological sense of the term.

Table 1 lists all known sites, whether extant, presumed extirpated or status unknown. They have been grouped into six general recovery zones (Figure 1), five of which currently have extant populations. The recovery zone boundaries themselves are intentionally not precisely defined geographically, but are positioned to lie between sites known to exist or to have existed in the past. They are intended to reflect the distribution Page for Figure 1, Distribution Map.

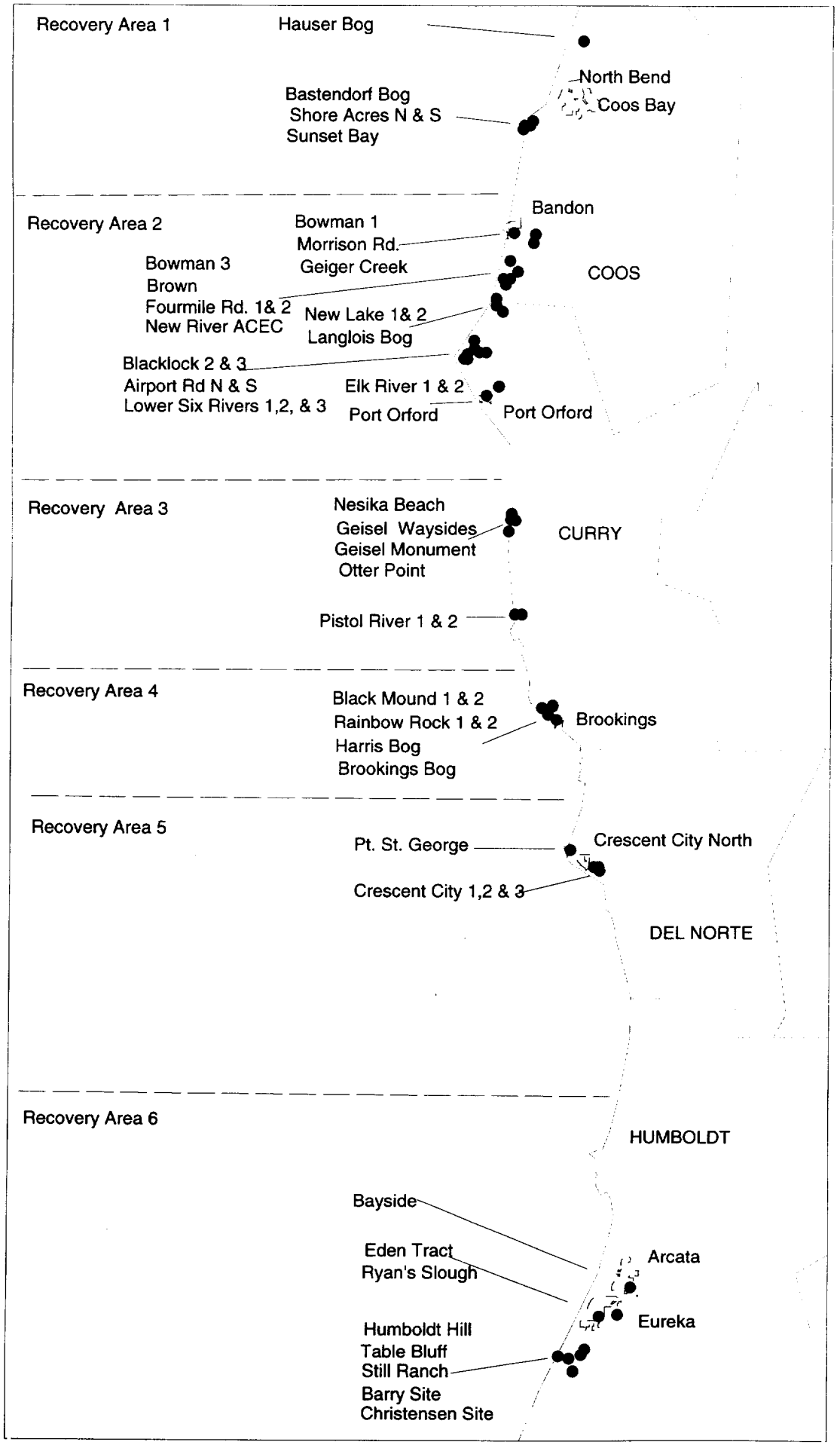


Figure 1. Map of known western lily populations, extant and extirpated

Table 1. Western lily populations known or suspected to be extant, presumed to be extirpated, or whose status is unknown. Listed in geographical order from north to south. Data are mostly from California and Oregon Heritage Data Base records (ONHP 1996, CNHP 1996), and Schultz (1989). EO (element occurrence) is the term used by these data bases for "sites." Population sizes without parentheses indicate the total number of plants at a site. Population sizes with parentheses refer to the number of flowering plants at a site. The year data were collected is indicated after size.

| Name | EO # | Population size | Owner, Comments |
|---|---|---|---|
| **Recovery Area 1** | | | |
| Hauser Bog | 013 | 25 in 1995 | Private, ODOT |
| Bastendorff Bog | 001 | 16 in 1993 | The Nature Conservancy and ODOT |
| Sunset Bay State Park | 001 | Status unknown | Oregon State Parks |
| Shore Acres N | | 14 in 1988 | Oregon State Parks |
| Shore Acres S | 016 | 84 in 1995 | Oregon State Parks |
| **Recovery Area 2** | | | |
| Bowman 1 | 004 | (3 in 1995) | Private |
| Morrison Road | 020 | 1 in 1992 | Coos County (Road right of way) |
| Geiger Creek | 021 | 6 in 1992 | Coos County (Road right of way) |
| Johnson Creek | 019 | 7 in 1992 | Coos County (Road right of way) |
| Old Bowman 2 | | Extirpated | Horticultural Origin |
| Old Bowman 3 | | Extirpated 1994 | Private |
| Brown | | Extirpated | |
| Fourmile Road 1 | | Status unknown | |
| Fourmile Road 2 | | Status unknown | |
| New River ACEC | | 2 in 1995 | BLM |
| New Lake 1 & 2 | | Status unknown | |

| Name | EO # | Population size | Owner, Comments |
|---|---|---|---|
| Langlois bog | 008 | Extirpated | Private, ODOT |
| Blacklock 3 | 025 | 2 in 1989 | Oregon State Parks |
| Floras Lake State Park | 03, 27 | 26 in 1994 | Oregon State Parks |
| Blacklock 2 | 026 | 35 in 1989 | Oregon State Parks |
| Airport Road N. 1 | 014 | (12 in 1994) | Oregon State Parks |
| Airport Road N. 2 | | Extirpated | |
| Airport Road S. | 014 | Status unknown | |
| Lower Sixes River 1 | | Extirpated | |
| Lower Sixes River 2 | | Extirpated | |
| Lower Sixes River 3 | | Extirpated | |
| Elk River 1 & 2 | | Extirpated | |
| Port Orford | 017 | Extirpated | |
| **Recovery Area 3** | | | |
| Nesika Beach 1 | | Extirpated | |
| Geisel Monument | 006 | Status unknown | |
| Geisel Monument State Wayside | | Extirpated | Oregon State Parks |
| Otter Point State Park | | Status unknown | Oregon State Parks |
| Pistol River 1 & 2 | | Status unknown | |
| **Recovery Area 4** | | | |
| Black Mound 1 & 2 | 015 | 100-300 in 1982 | Private |
| Rainbow Rock 1 | 024 | 40 in 1988 | Private |
| Rainbow Rock 2 | | Status unknown | |
| Harris Bog | 2,23 | 39 in 1994 | ODOT, Oregon State Parks |

| Name | EO # | Population size | Owner, Comments |
|---|---|---|---|
| Harris Beach State Park | 018 | 101-1000 in 1991 | Oregon State Parks |
| Brookings Bog | 9,22 | Extirpated | Private |
| **Recovery Area 5** | | | |
| Point St. George 1 | [25] | >200 in 1994 | Private, CDFG |
| Point St. George 2 | [26] | >100 in 1994 | Private, CDFG |
| Crescent City 2 | [27] | 14 in 1992 | Private |
| Crescent City 1 | [28] | 3,700 in 1992 | Private, CDFG (Crescent City Marsh Wildlife Area) |
| Crescent City | [29] | 26 in 1994 | Private |
| Crescent City | [30] | 42 in 1992 | CDFG (Crescent City Marsh Wildlife Area) |
| Crescent City 3 | [31] | 8 in 1994 | CDFG (Crescent City Marsh Wildlife Area) |
| **Recovery Area 6** | | | |
| Bayside | [14] | Extirpated | |
| Ryan's slough | [18] | Extirpated | |
| Eden Tract | | Extirpated | |
| Humboldt Hill | [04] | Extirpated | |
| Still Ranch | [05] | Extirpated | |
| Table Bluff | [22] | 1500-2000 in 1995 | CDFG |
| Barry site | [10] | 500-1000 in 1995 | Private |
| Johnson site | [21] | <200 in 1995 | Private |
| Christensen site | [24] | <100 in 1995 | Private |

of naturally occurring clusters of sites, and to ensure that recovery activities be distributed throughout the species' range in order to conserve naturally occurring genetic diversity. It is possible also that if new sites are discovered, for example, between Arcata and Crescent City, it may become necessary to designate additional recovery areas.

**Habitat and Ecosystem**

The western lily occurs in early successional bogs or coastal scrub on poorly drained soils, usually those underlain by an iron pan, or poorly permeable clay layer. Populations are found at low elevations, from almost sea level to about 100 meters (300 feet) in elevation, and from ocean-facing bluffs to about 6 kilometers (4 miles) inland. Detailed descriptions of western lily habitat sites are found in Schultz (1989) and Imper et al. (1987).

The climate is characterized by cool, wet winters and warm, dry summers. About three-quarters of the rain falls from October to May. Summers are dominated by the North Pacific high pressure zone which generates moderate but consistent northwest winds. Fog is common in the summer and moisture condensing on trees may increase annual rainfall by as much as a quarter.

Common associates include the shrubs salal (*Gaultheria shallon*), western wax myrtle ( *Myrica californica*), western spiraea ( *Spiraea douglasii*), huckleberry (*Vaccinium* spp.), blackberry (*Rubus* spp), black twin-berry (*Lonicera involucrata*), and glandular Labrador tea (*Ledum glandulosum*). Common tree associates include shore pine (*Pinus contorta* ssp. *contorta*), Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*), Port Orford cedar (*Chamaecyparis lawsonia*) and willow (*Salix* spp.). Common herbaceous associates include Pacific reed-grass (*Calamagrostis nutkaensis*), slough sedge (*Carex obnupta*), bunchberry (*Cornus canadensis*), staff gentian (*Gentiana sceptrum*), brake-fern (*Pteridium aquilinum*), peatmoss (*Sphagnum* spp.), and western tofieldia (*Tofieldia glutinosa*).

The western lily appears to require a habitat that maintains a delicate balance between having some surrounding shrubbery but not too much. Low (less than 1 meter

[3 feet] tall) vegetation is in most cases beneficial to the lily because it shelters juvenile plants from large mammal browsing, and provides heat cover in July and August. This protection is perhaps most critical in spring and early summer for seedlings, which seem to tolerate die back in May or June. However, dense, tall shrub growth reduces reproduction and survivorship, and closure of forest canopy eventually eliminates the population entirely. The flowers often emerge above the surrounding shrubs, gaining exposure to direct sunlight where they are available to pollinators, primarily hummingbirds. However, the smaller size classes, and even adult plants until they are within a week of flowering, are generally protected by shrubs from wind and direct sunlight. Plants growing in prairie habitats with little structural support tend to be smaller when they flower than those with support. Plants growing in cultivation tend sometimes not to be able to hold themselves erect without artificial support, suggesting that the surrounding vegetation may be an important component of their habitat. Even so, the western lily tends to be shaded out when the vegetation is especially dense or taller than about 2 meters (6.5 feet) (Ballantyne 1980, Schultz 1989).

Western lily populations appear to have been maintained in the past by occasional fires, at least at some sites in Oregon, and by grazing. Among the most serious current threats is loss of habitat due to ecological succession facilitated by aggressive fire suppression. What effects these vegetational changes have had on hydrological aspects of western lily habitat, and vice versa, are not well understood.

In Oregon, the occurrence of the western lily appears correlated with strongly acid, poorly drained, sandy ortstein (hardpan) soils, where it occupies early to mid-successional, and occasionally late successional, low-nutrient coastal bogs (mires), and possibly also early successional or regularly disturbed medium- to high nutrient bogs. In contrast, the original plant associations in many California populations are less well known, even though the soils on which they occur are well delineated. Presently, many California populations, but not most of the western lily plants, occur on poorly drained pasture with relatively intact soils and a long history of grazing disturbance. If the soils have not been too badly damaged, such sites can sometimes return to scrub/prairie vegetation relatively

quickly when grazing is removed.

Salzer (in litt., 1994) raised the question of whether human-mediated alterations to the natural hydrological regimes caused changes to the vegetation at lily sites. He writes:

> "I wonder if succession to trees and shrubs used to be much more limited because the sites were historically wetter. If this were true, then Western lily may not be strictly an early successional species. For example, at Bastendorff Bog, has road construction (with associated ditching), and adjacent residential development contributed to a lowering of the water table, which then led to increased tree and shrub establishment and growth? Or was the establishment and initial growth of trees and shrubs a result of fire suppression that subsequently led to a lower water table through increased transpiration or through roots penetrating the hard pan and draining the bog? If this latter hypothesis is true, a positive-feedback process is probably accelerating the demise of the bog."

**Life History and Ecology**

The life history of the western lily has been studied much more extensively than most other endangered species (Ballantyne 1980, Imper et al. 1987, Schultz 1989, Skinner 1988). Like other lilies, western lily has hermaphroditic flowers (producing both pollen and seeds). It reproduces primarily by seed, but asexual reproduction is possible from detached bulb scales growing into new plants.

Seed germination is hypogeal (the cotyledon or seed leaf stays beneath the surface of the ground). A bulb scale is formed in the fall, and the first true (or epicotylar) leaf emerges the following spring. In cultivation at least, plants may take 4-5 years to flower for the first time (Schultz 1989), and may live for 25 years or more (Kline 1984). Young flowering plants generally produce a single flower in each of the first few years after they begin to flower, and later produce progressively more flowers if they experience favorable environmental conditions. Populations of non-flowering individuals may persist for many years under closed forest canopies (Imper et al. 1987). It is not clear whether these represent the remnants of populations that flowered in the past when conditions were

different, or are the product of dispersal into conditions that allow juveniles to persist but not reproduce. In nature, shoots emerge in March-April (sometimes as early as January, at least in California) and continue to elongate until the flowers open. In May to July, green buds turn red for 3-5 days, open over a period of 1-2 days, and the nodding flowers last for 7-10 days. After the floral parts have fallen off, pedicels (flower stalks) become erect within a week and capsules enlarge to maturity over a period of 40-50 days. Natural seed set in a 1987 sample of 35 capsules at Bastendorff Bog, Hauser Bog and Shore Acres ranged from 0 to 204 seeds per capsule with a mean of 132 seeds and a standard deviation of 31 (Schultz 1989). Seeds are primarily dispersed by wind and gravity, mostly within a 4-meter (13 foot) radius. Each year the above ground portion of the plants die back and individuals overwinter underground as rhizomes/bulbs. Dead, above-ground shoots may persist for one or more years in protected sites before they collapse and decompose.

Hummingbirds are the primary pollinator of western lily, but some bees and other insects may also occasionally transfer pollen (Skinner 1988, Schultz 1989). Low fruit set in isolated plants or those concealed in dense vegetation, relative to those plants in groups with flowers free of surrounding vegetation, underscores the importance to the plants of their flowers being available to hummingbirds (Schultz 1989). In a comparative study of the pollination ecology of seven west coast lily species, Skinner (1988) found that the western lily produced more nectar in a day than any other lily species—almost twice the amount of the runner-up *Lilium maritimum*, and over 15 times as much as the least productive *L. humboldtii.*

Species in the genus *Lilium* generally have a strongly developed gametophytic self-incompatibility system, meaning that plants generally cannot successfully pollinate themselves (Skinner 1988, Schultz 1989). However, the western lily may be unique in the genus in being able to produce considerable quantities of self-pollinated seed (Skinner 1988; Imper, Independent Consultant, Eureka, CA., pers. comm., 1996). In contrast, Schultz (1989) concluded that western lily is obligatorily out-crossed after several bagged, hand-selfed plants failed to set seed. Skinner examined fewer flowers of western lily than of other species, so further clarification on the western lily's breeding system in general,

and self compatibility in particular, is an important research need. Nevertheless, with or without an effective self-incompatibility system, many of the small populations of western lily are probably subject to increased inbreeding. Schultz (Biology Department, University of Miami, pers. comm., 1996) and Imper (pers. comm., 1996) have noted the existence of plants with misshapen flowers and those with uncharacteristic numbers of floral parts, which may be evidence of inbreeding depression, or expression of deleterious mutations.

The existence of significant genetic differentiation among populations of western lily is probable for several reasons. First, such differentiation is commonly found in plants, sometimes on a very small spatial scale, regardless of the mating system and even in the presence of substantial gene flow between populations ( Bradshaw 1972; Heslop-Harrison 1964; Levin 1979, 1981, and 1993; Levin and Kerster 1974; Raven 1986; Sobrevila 1988; Waser and Price 1989). Second, there is probably no gene flow between major western lily concentrations at Hauser, Cape Arago, Bandon, Brookings, Crescent City, and Table Bluff. Third, selective conditions vary across these lily concentrations due to differences in soil composition and development, climate, plant community associations, and probably history of exposure to pathogens and predators; such differences may have resulted in some adaptive genetic differentiation. Fourth, populations are small and subject to substantial random genetic drift, and may have become fixed by chance for different alleles at many loci. And finally, the among-population variation in a variety of morphometric traits (leaf length and width, number of leaf whorls, plant height, outer tepal length and width, pistil length, stamen length, filament and style curvature, number of flowers, color of inner and outer tepals, and date of first anthesis in 1987) was very highly statistically significant (Schultz 1989). Sources of such variation include genetic differentiation as well as phenotypic plasticity in response to different environmental conditions, and differences in mean adult age among populations.

Long-term monitoring data are available for several populations at the northern and southern extremes of the species' range. At the southern end of the range, the Johnson (Imper 1987a-1994a), Barry (Imper 1988b-1994b), Christensen (Imper 1988c, 1989c; McRae and Imper 1990 and 1993-1994, McRae 1991-1992), and Table Bluff

Ecological Reserve (Imper and Sawyer 1988, 1990-1994) sites have been monitored for almost a decade, as has the Bastendorff Bog site at the northern end of the range (Salzer 1994). More recently, additional monitoring has been instituted for other populations (Rittenhouse 1994, 1995), using the monitoring protocol described at the end of this recovery plan.

**Reasons for Decline and Current Threats**

The Endangered Species Act specifies that species may be determined to be threatened or endangered due to one or more of the five reasons listed below, all of which apply to the western lily to a greater or lesser extent. The reasons for listing western lily are described in greater detail in the final rule (59 FR 42171).

**A. The present or threatened destruction, modification, or curtailment of habitat or range.**

The western lily is limited to habitats on relatively level ground near a scenic coast with a moderate climate and within a day's drive of two major urban areas. It is hardly surprising, therefore, that the species has been, and continues to be, under intense development pressure. A partial list of known losses and current pressures follows.

Western lily populations have been extirpated from many sites across virtually its entire range. In Oregon, the area from Bandon south to Cape Blanco, which as recently as 45-55 years ago contained perhaps the greatest concentration of this species in the state (Ballantyne 1980, Schultz 1989), has experienced the loss of numerous populations and considerable suitable habitat to various forms of development, including the creation of commercial cranberry bogs, residential development, and utility and road construction and maintenance. Many of the once numerous populations and their habitat near the Elk and Sixes rivers in Oregon have been lost to clearing and drainage for livestock grazing (Ballantyne 1980). As recently as 1992, whole populations within the city of Brookings

and on State of Oregon lands have inadvertently been destroyed. In California, several populations around Humboldt Bay were extirpated by development or forest encroachment, presumably facilitated by aggressive fire suppression throughout much of this century. In addition to outright habitat destruction, development has likely degraded the hydrological conditions for western lily because of the activity at neighboring sites.

In California, degradation of soils by agricultural plowing over the past century and a half may have been the largest single factor contributing to loss of habitat. Soils in which the western lily occur often have very low dry bulk density, ranging between 60-70 pounds per cubic foot (pcf)(Imper and Sawyer 1994b).

The potential for future development continues to pose a serious threat to the species throughout its range, and is likely to increase. By far the largest known western lily population is partly on private land near Crescent City, California, much of which has been subdivided. This population is being impacted by logging, grazing and residential development on surrounding lands.

In 1994, the new private owner of land with a lily population apparently eradicated it by bulldozing the site. The family of the former owners report that the new owner has recently begun to clear 80 acres of the site for new commercial cranberry bogs. During this same period, properties on both sides of another population in the Bandon area were cleared for development (Guerrant, pers. comm., 1997).

**B. Overutilization for commercial, recreational, scientific, or educational purposes.**

Western lily is a very showy plant with great horticultural appeal. Following the publication of specific site locality information, excessive bulb collecting by lily growers, breeders, or other enthusiasts appears to have decimated one population at least three times (Ballantyne 1980). Sporadic collection continues to be a problem. For example, Schultz (1989) documents that 7 bulbs were collected from one site in 1987. Seven bulbs is a significant loss because this is greater than the size of some entire populations (Table 1).

**C. Disease or predation.**

Although probably not as serious as other threats, grazing by vertebrates (elk, deer, voles, and domestic cattle) and invertebrates (coleopteran and lepidopteran larvae) has been documented. Of these grazers, deer may represent a major threat, at least in California. Even if not lethal, deer remove a considerable fraction of flowers and fruit, thus seriously reducing the reproductive output at many sites.

Deer herbivory has occurred at nearly all sites, and has numerous times eliminated over half a population's annual seed production. Deer typically consume the fruiting capsules while they are still green, along with the leaves. They occasionally consume flower buds and open flowers. The concentration of adult lilies in small open areas increases their vulnerability, especially after removal of encroaching vegetation that undoubtedly reduces their visibility and accessibility. While large (greater than 1,000) adult populations in diversely structured habitat may withstand normal browsing activity, most populations would greatly benefit by deer exclusion, especially during and after vegetation control. The pattern of vegetation removal will affect deer behavior, and simultaneous clearing of areas away from lilies might serve as a positive redirecting function. Small mammals are also known to graze on the western lily, and McRae and Imper (1994) cite a situation of major impact by small mammals for the Christensen site.

Cattle are reported to have reduced one population to fewer than 10 individuals in 1988 from its previous size of over 100 in 1984 (U. S. Fish and Wildlife Service 1994). However, apparent low mortality as a result of cattle grazing is demonstrated by data collected at the Table Bluff Ecological Reserve for the past 12 years. A fixed plot was monitored for 4 years prior to exclusion of cattle in 1987, and the 8 years since then. While the annual average number of flowering plants was less during the grazed years (i.e., greater fluctuation due to grazing impacts), the maximum number of plants was equal both before and after. The same relationship held for total number of plants, although the maximum number during grazing was actually greater than during the post-grazing period. Overall monitoring data for the past 8 years at all sites on Table Bluff has documented

decline in total of number plants, particularly juveniles, following removal of cattle. Thus, the evidence strongly suggests that while cattle grazing limits individual reproductive potential, at the population level this negative impact may be less significant and in some cases, the impact may even be positive.

The relationship between cattle grazing and western lily is complex. Without question, cattle grazing limits reproductive potential of mature plants. Exclusion of grazing at three of the four sites on Table Bluff in the late 1980's led to an immediate tripling of flowering and fruit production. Although cattle represent an obvious physical hazard to individual plants during the growth period, evidence indicates that past categorical characterization as a principle threat may be overstated. Observation indicates that, more often than not, damage to the western lily by cattle is through physical trampling rather than actual consumption, and in areas not severely overgrazed, the tendency is for cattle to remove only the upper portion of the plant as a consequence of feeding on surrounding vegetation. In contrast, deer and several small mammals are very selective for western lily, often removing the entire shoot. The different modes of grazing are significant, since the lily appears well able to tolerate trampling or partial removal without die back, thus deriving benefit from photosynthesis for the remainder of the season. Therefore, the impact of cattle may often only represent a short-term loss of an individual's growth rate or reproductive potential, which is to some degree compensated for by the reduction in competition.

There are other reasons for the apparent positive relationship between grazing and western lily survival. Cattle clearly have been an important historical factor in suppressing vegetation succession and maintaining habitat in a condition suitable for the western lily. This inference is supported by the fact that virtually all surviving populations in California and some in Oregon have a long grazing history. Cattle may play a direct role in the reproductive ecology of the western lily as well. There is evidence that western lily seed can pass through cattle intact, and germinate in the feces (Imper 1993a). Presumably, the resulting seed bed is conducive to seedling growth and establishment in a microsite temporarily free from competition. The degree to which such seedlings can become

established in the soil is not known. Concentrations of seedlings are often associated with cattle rest areas or pathways. A likely reason is that successful establishment in habitats subject to dense competition require a physical means (e.g., hooves) for penetrating down to the soil and ensuring moisture availability late in the season. However, the long-term soil compaction by cattle may be a problem.

**D. The inadequacy of existing regulatory mechanisms.**

As was mentioned on page 1, western lily is listed as an endangered species by both the states of California and Oregon. In addition, the species is included in the Oregon Wildflower Protection Act. The California Endangered Species Act incorporates the take prohibition of the Native Plant Protection Act. As currently interpreted, this legislation only requires that landowners notify the Department of Fish and Game ten days in advance of a change in land use to allow the Department to salvage the plants. However, the cases in which this salvage notice requirement applies are still in question. In Oregon, the "take" of plants is prohibited only on state-owned or leased lands.

The majority of surviving populations are on state land in both Oregon (Departments of Parks and Recreation, Transportation) and California (Department of Fish and Game), where they receive full protection from each states' Endangered Species Act. The primary protection on private land is provided by section 404 of the Clean Water Act (CWA), administered by the U.S. Army Corps of Engineers. The CWA's definition of "wetland" is broad and may include most, if not all, of the habitat occupied by western lily. The CWA prohibits certain types of wetland modifications unless an individual permit is obtained. Permits may be granted only if the proposed activity does not jeopardize the continued existence of federally endangered or threatened species. Although wetlands on private lands are partially protected, lily populations on private wetlands will not necessarily remain stable unless the habitats are properly managed. This would be facilitated by the development of a formal, centralized landowner contact program in Oregon, and the long-term continuation and perhaps expansion of the land

owner contact program already implemented by The Nature Conservancy in California (Lozier 1987, 1995).

All non-exempt activities that impact wetlands in California are subject to the California Environmental Quality Act (CEQA), and therefore must consider western lily. Regulatory mechanisms for controlling cranberry development are lacking, and few permits are required. There is a need for additional triggers for environmental review. For example, all ground-disturbing projects within the five occupied recovery areas should trigger some level of environmental review by agencies.

**E. Other natural or manmade factors affecting its continued existence.**

Probably the most significant long-term threat to the western lily is competitive exclusion by shrubs and trees. Heightened competition is a consequence of the rapid and uninterrupted progression of ecological succession resulting from fire suppression throughout the latter part of this century. While heavy cattle grazing may badly damage populations, some cattle grazing appears to have been a significant factor slowing or halting succession, and may have helped maintain the western lily at some sites. The use of fire by Native Americans may also have been a significant factor in slowing or halting succession. For example, in Oregon, there is archeological evidence of habitation by Native Americans near several western lily sites, and of the regular use of fire, presumably to clear areas for protection from enemies and to cultivate useful plants.

The species appears not to be able to successfully compete if canopy cover is over 50 percent, or with shrubs over 2 meters (6.5 feet) high (Ballantyne 1980). Nevertheless,

Loss of genetic variability is a threat to small populations. Populations below an effective size of about 5,000 will generally maintain insufficient adaptive genetic variability for long-term evolution in response to a changing environment, and those below 500 will experience accumulation of mildly deleterious mutations due to random drift, expression of inbreeding depression, and cross-incompatibility due to loss of self-incompatibility alleles (Lande 1995). Lynch et al. (1995) show how populations under 1,000 individuals ($N_e$=100) are vulnerable to "mutational meltdown" on time scales of approximately 100 generations. They also suggest that this number is too low and that populations should be maintained at higher levels. All these threats will be nearly eliminated if populations can be maintained at effective sizes ($N_e$) exceeding a few thousand or a census size of tens of thousands. Large populations in spatially complex habitats will also be well protected from most sources of environmental stochasticity, such as mammal grazing.

In the past, populations of western lily were certainly highly clumped and may often have contained fewer than a few hundred adults. However, a larger effective size most likely prevailed as a result of moderate gene flow among populations (presumably due to seed transport internally by deer, and possibly pollen transported by hummingbirds), which were undoubtedly more abundant and less isolated from each other than at present.

**Conservation Measures**

The endangerment of the western lily has been recognized for a long time. Much has been and is being done to recover the species already by public agencies, and private organizations and individuals.

In California, private individuals, in conjunction with Humboldt State University and the California Department of Fish and Game, have had a formal management plan in place since 1987 for the Table Bluff site (Imper et al. 1987). Since that time, considerable work has been done to recover the western lily at the Table Bluff Ecological Reserve site and an extensive yearly monitoring record has been generated at this site (Imper et al.

1988-1995) and the three nearby sites on private land (Johnson site, Imper 1987a-1994a; Barry Site, Imper 1988b-1994b, and Christensen site: Imper 1988c, 1989c; McRae and Imper 1990 and 1993-4, McRae 1991-2). In addition to relatively passive measures (such as fencing to exclude cattle) various forms of experimental habitat manipulation have been attempted, and an experimental reintroduction program has been established for the Table Bluff Ecological Reserve (Imper and Sawyer 1994b). Additional experimental habitat manipulation and monitoring studies, facilitated by The Nature Conservancy, have been conducted on three private holdings in the vicinity of Humboldt Bay — the Barry, Christensen, and Johnson sites (Imper 1994a, Imper 1994b, and McRae and Imper 1994).

In Oregon, The Nature Conservancy has been monitoring a small population at Bastendorff Bog since 1985, and in 1994 initiated experimental manual vegetation removal in an attempt to reverse a well documented decline in population size (Salzer 1994). The Berry Botanic Garden has a few collections of western lily seed in the Seed Bank for Rare and Endangered Plants of the Pacific Northwest. The collections are biased toward populations near the northern and southern limits of the range. There is also a seedling bank project at Humboldt Bay (Imper and Sawyer 1994b).

This recovery plan has taken advantage of the ongoing work, and attempts to support and build on it, rather than start from the beginning or replace it altogether.

**Recovery Strategy**

The recovery strategy has three main components. The primary component is on-site protection and enhancement of natural populations. This is supported by an off-site program of seed banking and experimental population reintroduction and enhancement, intended as "bet hedging" measures to create more management options in the future. The final component of the recovery strategy is public outreach to inform the public about the plight of the western lily, why it is endangered, and what can and is being done to recover it. This should encourage public participation in various aspects of recovery.

## II. RECOVERY.

### Objective

The goal of this plan is to stabilize and protect existing occupied sites as viable populations so that the species can be reclassified as a threatened species, and upcoming revisions will set delisting criteria so that the species can eventually be delisted (Figure 2, Tasks 172 and 191).

**Criteria for reclassification to threatened status:** the western lily can be reclassified when at least 20 populations (each equivalent to a single management area, described later) distributed among the six recovery zones that span the known range of the species are protected and managed to assure their long-term survival. The distribution of these 20 populations shall be three in zone 1, five in zone 2, and four in zones 4, 5, and 6. If possible, more populations should also be protected. The purpose of protecting this many populations throughout the species' range is to conserve at least the majority of what is left of the species' genetic diversity that is distributed in an incompletely understood, but apparently complex clinal fashion across the species' largely north-south range.

For the purposes of this plan, a viable population includes a stable or growing population of at least 1,000 plants, on average during any three consecutive years, that flower, and enough other individuals appropriately distributed among smaller size classes for the population structure to be self-sustaining. For the purposes of this recovery objective, a flowering plant is an individual that produces a flower, but does not necessarily produce seeds. Long-term demographic studies on several focal populations will be necessary to determine an adequate stage structure for population viability (Pavlik 1994). The figure of 1,000 flowering plants is derived from recent work by Lande (1995) and Lynch et al. (1995). While this is clearly an ambitious goal, these population sizes are probably not high enough to conserve the long term evolutionary viability of populations, and thus, may need to be increased to de-list the species.

Protected habitat is habitat that is being actively managed and protected in

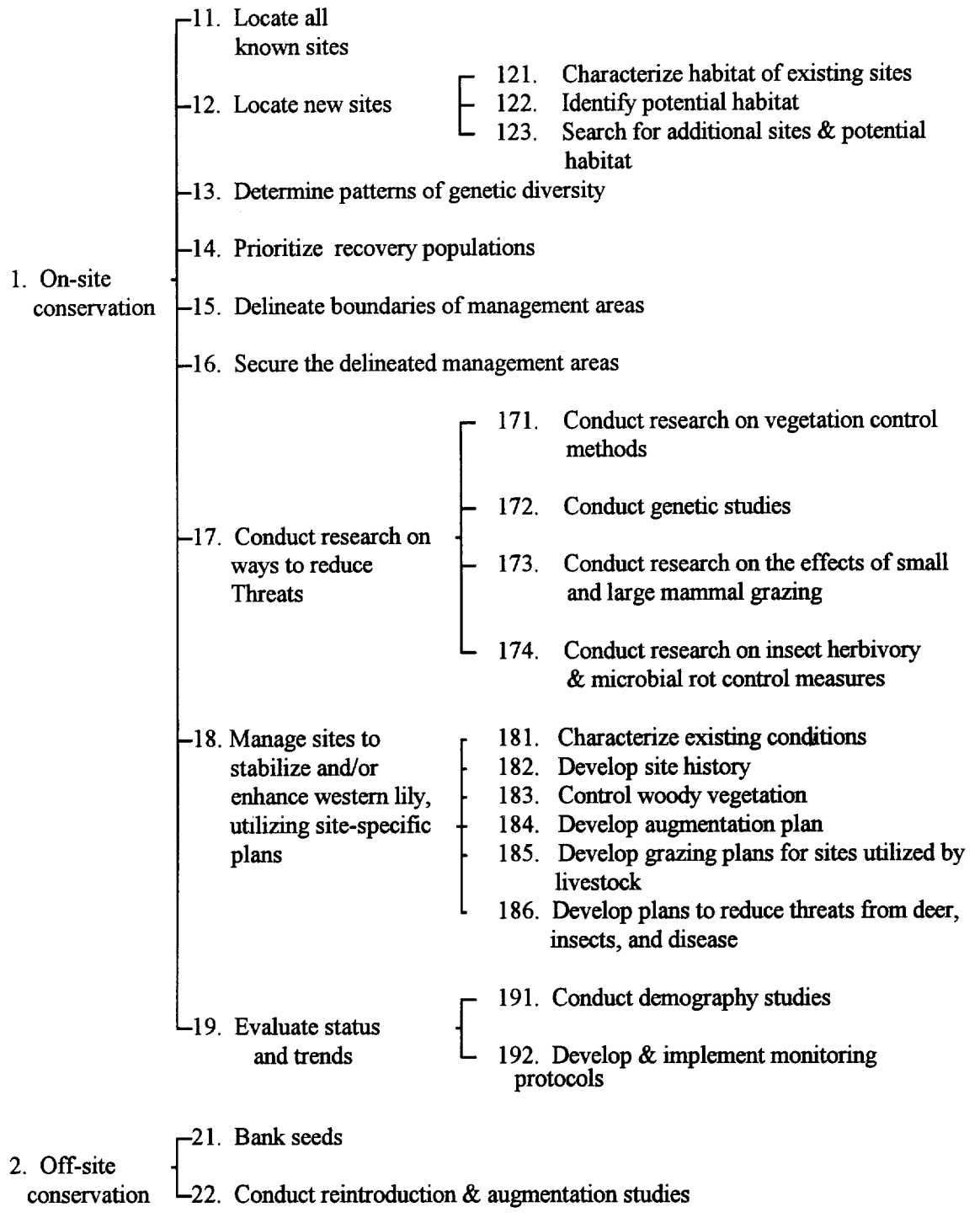


Figure 2. Diagram of step down outline to accomplish downlisting for the western lily

perpetuity with western lily maintenance and enhancement as the primary goal. This includes ongoing active management to eliminate the threat from woody invasion.

**Narrative:**

**1. On site conservation: the heart of recovery.**

On-site (*in situ*) conservation is the heart of recovery. This recovery plan augments *in situ* efforts with off-site (*ex situ*) methods, and with public outreach. Until specific sites are selected for accomplishing recovery, protection should be afforded to as many sites as possible.

**11. Locate all known sites.**

The purpose of this task is to assemble all available information necessary to make informed decisions about which populations can or cannot contribute to the recovery of the species. This task can, in part, be conducted concurrently with task 181, which initiates site management with initial assessment of population size and threats, and examination of areas suited for population expansion.

Much has been done to accomplish this task, but not all available information has been assembled into any one document or data base. The primary repositories of this information are the Heritage programs in California and Oregon. However, these do not include all extant or extirpated populations (including herbarium records) listed by Schultz (1989), who in turn does not include all populations in the Heritage data bases.

All available information about all known extant and extirpated populations should be assembled for the Service's Oregon State Office and the Oregon and California Heritage Programs. Ownership of all population localities should be established, especially for those populations that might involve more than one owner. For each population, ascertain current land management objectives and any planned or likely activity that might harm western lily. Ascertain willingness of landowners/managers to participate in recovery of western lily.

A summary of the current understanding of known sites, their population size and ownership is found in Table 1 (see also Figure 1).

**12. Locate new sites.**

The narrow range of the western lily appears to be well defined. It is in an area that has been relatively well-explored botanically. The western lily is a very showy species that has long received considerable attention from academic and horticultural audiences. However, the western lily is very difficult to find and to identify, except for a short period in June and July when the plant is in flower. Since many of the known populations are very small and are at sites that have become increasingly densely vegetated, searches can be conducted successfully only when the western lily is flowering. For these reasons, it is probable that not all populations have been found. Locations to the north and south of the known range should be investigated.

**121. Characterize habitats of existing sites.**

To facilitate the search for new populations and suitable unoccupied habitat and to aid in restoration of existing populations, the habitat of all known populations should be characterized. This description should include gathering information on current vegetative composition, and physical attributes of the sites such as elevation, aspect, slope, and especially soil types. To the degree possible, hydrological aspects of each site should be characterized as well.

**122. Identify potential habitat.**

Use information from Task 121 on characterization of existing habitats to identify areas that are potentially suitable for the western lily, using soil maps and aerial photographs, in combination with information from people who know the local area. The area between Bandon and Cape Blanco appears historically (45-55 years ago) to have had the greatest concentration of the species in Oregon (Ballantyne 1980) and is thus an

area particularly likely to support additional populations. This area is also important because it has a large amount of potentially suitable habitat (based on present vegetation and soils), and also is currently under intense development pressure. Other areas needing additional survey efforts are low valley wetlands between Orick and Prairie Lagoon in California that might contain as yet undiscovered western lily sites, and the area south of the current southern end of the range. For example, geological maps suggest suitable soil might be found near the mouth of the Mattole River.

**123. Search for additional sites and potential habitat.**

A systematic search for new populations and suitable unoccupied habitat within the potential habitat areas identified in Task 122 should be implemented and well documented. Documentation should include the criteria used to identify search areas, a record of the areas searched both successfully and unsuccessfully, and search dates. The information should be made available to the Service.

**13. Determine patterns of genetic diversity.**

Morphological and phenological studies strongly imply a complex pattern of genetic diversity within and among populations along a north-south cline (Schultz 1989, and unpublished data). However, no molecular or quantitative genetic data are available to quantify the distribution of genetic diversity within and among populations. A comprehensive study to characterize the amount and patterns of genetic diversity within and among populations should be conducted.

**14. Prioritize recovery populations.**

Unless searches for "new" populations prove unexpectedly successful, no western lily populations with substantial numbers of individuals, or the potential to support them, can be spared. All the populations discussed in Appendix 1 (page 56) are important. Criteria used to prioritize populations for recovery should include, but not necessarily be limited to the following: current population size

and stage structure, land ownership, surrounding land use, site hydrology, successional status, potential for expansion of suitable habitat, and reintroduction and augmentation potential. The last two criteria are especially important for smaller populations that will probably require some form of demographic intervention to achieve population sizes necessary for downlisting.

Using all available information, the recovery sites should be prioritized, in consultation and concurrence with private landowners, and the appropriate state and federal agencies. These shall include, but are not necessarily limited to The Nature Conservancy and other private landowners, the Oregon Departments of Agriculture, Transportation, and Parks and Recreation, the California Department of Fish and Game, U.S. Bureau of Land Management, U.S. Army Corps of Engineers, along with local governments such as counties or cities that are directly affected.

**15. Delineate boundaries of management areas.**

Once recovery task 14 has been accomplished, management areas need to be established. This entails delineating the boundaries, and securing the habitat within them. Figure 1 shows the general locations of the known extant sites. A management area is a specific geographic area that has been delineated on a map with boundaries that include all the necessary habitat and plants to sustain a viable population. In some areas, such as around Blacklock Point in Oregon, several to many small sites are recognized and are currently tracked separately by the Heritage Program. Such a localized constellation of sites may comprise a single management area. If so, special attention will need to be paid to the demographic and genetic implications of dispersed (meta-) population structure.

The boundaries of management areas selected for recovery should be delineated on a map or aerial photograph of the appropriate scale to clearly identify the geographical area to be managed for the recovery of the western lily. Sufficient habitat and supporting area surrounding each population should be

included in each management area. Possible criteria for delineating management areas include not only areas with populations and appropriate habitat, but also adjoining areas that might be hydrologically important to the habitats, and other factors found to be important at each site.

**16. Secure delineated management areas.**

For a management area to contribute toward recovery, legally binding arrangements must be made to assure that the land, public or private, will be managed perpetually for the benefit of western lily. Once the management areas have been delineated and agreed upon, the landowners should examine management options to administratively protect each area (Lozier 1987, 1995). Only two western lily plants occur on federal land. Much of the habitat is owned and managed by the states of Oregon and California, or their subdivisions. However, significant numbers of individuals and populations are on private land. If private owners are not interested in entering into conservation agreements to protect populations deemed necessary for recovery, an attempt should be made to provide positive incentives for them to do so, or to acquire sites from willing sellers at negotiated prices by state, federal, or private conservation groups who would protect and manage them.

**17. Conduct research on ways to reduce threats.**

Research is needed to find ways to reduce the most serious threats.

**171. Conduct research on vegetation control methods.**

Western lily appears to be a stress-tolerant, competitively inferior species dependent on transitory, early successional conditions. At each site within its current distribution, succession would eventually eliminate the species in the absence of sporadic intervention. Prior to European colonization and land development, the lily most likely survived as a

metapopulation[1] in which the rate of population extirpation was balanced by the rate of colonization of open wetlands newly created by fires, dune movement, or animal activity. Burning by Native Americans may also have been a significant factor, at least for some populations. Fire control and dune stabilization have prevented the creation of new habitat and most pre-existing habitat has been, or will soon be developed. The lily cannot be expected to naturally colonize new habitat, and maintaining the species in nature will be virtually impossible without a permanent program of regular vegetation control at each population site.

A major research need is to review of the feasibility and efficacy of options, materials, and methods for vegetation control. The review should focus on the use of fire, controlled cattle grazing, and manual vegetation removal. The best management approach at a site will depend on the rate of vegetation encroachment, the stage of succession, the life form (e.g., tree, shrub) of the species to be controlled or removed, the size and ownership of the site, and the type and density of neighboring developments.

Because manual vegetation removal will be a major and widespread management tool, the effects of different patterns of manual vegetation removal should be compared with careful experiments (Salzer 1994). For example, investigations should determine whether repeated cutting of some shrub species at a consistent height may lead to a thick hedge, which could shade out small lily plants, or whether cutting shrubs at ground height may decrease the structural support for the lilies and encourage other plant community types to develop. At the very least, experiments are needed to examine the effects of height of cutting and selection of plants to cut.

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[1] Roughly, a group of populations that exchange genes at least occasionally. Over a long period of time, local populations are founded and go extinct while a metapopulation persists.

Vegetation removal can have negative effects, including:

• invasion of introduced species, such as *Holcus lanatus* (velvet grass) especially at Table Bluff, California; *Ulex europaea* (gorse) in the Bandon area; and *Rubus discolor* (Himalayan blackberry) everywhere,

• expansion by native, competitively superior colonists (such as *Spiraea douglasii* and *Rubus ursinus* (California blackberry),

• alteration of the heat and moisture regime, which at many sites may cause temporary heat shock to juvenile plants; and

• increased accessibility to deer, elk, and humans.

A combined program of vegetation control and deer exclusion or redirection might be necessary at most sites.

Prescribed burning is a natural and potentially labor-saving option where it can be employed. Burning can be an effective means of clearing low woody vegetation (including small trees) and maintaining early successional vegetation. However, it may not be effective or feasible in eliminating canopy trees, due to the difficulty of maintaining a canopy fire in sparse forest, and the difficulty of regulating its burn rate and movement in a closed forest. Burning also may not be feasible in some years and in some habitats that retain a high vegetation moisture content late in the season. The use of fire as a management tool depends on having burn plans in place that can be used on short notice as conditions permit. Sites currently with sparse forest may be managed with a combination of understory burning (every five years) and girdling of all overstory trees (one time only). Densely forested sites, however, will be extremely difficult to manage, thus emphasizing the need for aggressive vegetation control prior to this stage. Girdling of trees in a closed forest will have only small immediate effects, since the dense branch growth will continue to shade the understory even in the absence of foliage. Such sites will

require removal of limbs and their disposal offsite. In a dense forest this amounts to the slow, manual removal of an enormous volume of woody debris. This material should not be allowed to accumulate in lily habitat, since it would impair reproduction and provide safe sites for aggressive competitors such as *Rubus discolor* and *Rubus ursinus*, and perhaps also for small herbivorous mammals.

**172. Conduct genetic studies for site management.**

Conduct genetic and ecological studies such that the amount and pattern of genetic diversity within the species can be determined, and the effective population sizes of different management areas can be estimated. These data are needed to assure appropriate genetic management with respect to site management and population augmentation and reintroduction (task 2).

**173. Conduct research on the effects of small and large mammal grazing.**

As explained in the background section, herbivory by deer, and to some extent by cattle, appears important. Yet it is not appropriate to simply attempt to fence out deer and remove cattle. In particular, nearly all remaining sites where the lily occurs have long histories of grazing. Observation of herbivory should be part of demographic studies and monitoring of the effects of vegetation management.

**174. Conduct research on insect herbivory and measures to control microbial rot.**

Insect herbivory and microbial rot appear to be relatively uncommon and episodic, but could increase as populations recover and lily

densities increase. Effective control measures for these threats need investigation so they may be immediately available in cases of sudden infestations. Monitoring programs should include monitoring of disease outbreaks to see whether there is geographical variation in resistance. Strong resistance to fungal and bacterial infection is necessary for any plant with permanent underground storage structures, and it is possible that there may be geographical variation in genetic resistance to pathogens due to geographical variation in species of pathogens and in resulting natural selection of genetic alleles for disease resistance.

**18. Manage sites to stabilize and/or enhance western lily, utilizing site-specific plans.**

Management planning and implementation is already proceeding at some protected sites (see Appendix 1). Using all available information, including what becomes available from research (tasks 171 to 174), site specific management plans must be developed for each of the 20 management areas delineated in task 15. Population enhancement will involve active and adaptive management of populations and their habitats. Although general and specific suggestions can be made, stabilizing and enhancing populations is a population-specific activity contingent on existing conditions that change over time. Where possible and prudent, all significant management activity should be conducted as formal scientific experiments, with specific hypotheses to be tested, and sufficient and appropriate monitoring data gathered before and after treatment to evaluate the effects, if any, of the management action (Pavlik 1994, 1995). In this way, the most effective measures can be found and deleterious actions can be discontinued. The first goal of site management is to enhance the habitat so the existing population will naturally increase. At some future time, reintroductions or augmentation may be found to be prudent at some management areas.

**181. Characterize existing conditions.**

In general, enhancement begins by making an initial assessment of population size and stage-structure, and of specific threats to that population. Each population is probably ultimately limited by soil conditions (e.g., restricted to soils with a slowly permeable clay layer in coastal scrub habitat, or an iron hardpan on Blacklock soil). Work on expansion of populations must begin with surveying the soil conditions and potential habitat boundaries at each site, as well as identifying areas to clear vegetation outside the limits of the current lily population.

**182. Develop site history.**

Detailed site histories for all management areas, and all other known sites if possible, will help in developing site specific plans to reduce competition (Salzer 1994). Fire frequency can be inferred from fire scars on trees, and possibly charcoal remains, and for many sites aerial photographic histories may extend back for half a century or more. Early cadastral surveys from the mid to late 1800s included maps showing prairie and forest boundaries. There is archeological evidence for regular burning along the south coast of Oregon, by Native Americans, in areas currently occupied by western lily (S.T. Schultz, in litt., 1994).

**183. Control woody vegetation.**

The basic management required at nearly all sites is the same, namely the timely and repeated removal of all trees and dense tall shrubs. Since the labor required for tree removal and its negative side effects increase exponentially with age of the trees, their removal is strongly recommended from nearly all sites as early as possible, and should be repeated approximately every five years, or more frequently if convenient. If performed at this rate, the labor will be minimal. Logging or clearing with heavy machinery is not an option due to the likelihood of intolerable

soil compaction (in any case, larger old trees, such as the 90-year-old stand at Table Bluff Ecological Reserve may be beneficial to western lily by slowing succession while still allowing the lily to flower. Such conditions may also favor the survival of juveniles).

Since recovery of the western lily requires an increase in the total population by at least an order of magnitude, each site should be managed not only to protect, but also to expand the existing population.

**184. Develop augmentation plan.**

If populations can be brought to large effective sizes through site management over the next decade, measures for genetic improvement will likely be unnecessary except in the smallest, most endangered populations (e.g., those whose fecundity might drop to near zero due to fixation of incompatibility alleles). Since recovery of populations to large effective sizes is in fact likely to be slow, transfer of pollen, seed, or seedlings between adjacent populations will probably be needed. The resulting gene flow would reduce the level of inbreeding within populations, increase mean heterozygosity, and maintain a greater mean number of alleles per locus, thus reducing the probability of fixation of deleterious or incompatible alleles. Transfer, however, should occur between neighboring populations only, so that breakdown of population-specific, and possibly adaptive gene complexes can be minimized. Explicit records should be kept and provided to the Service. An explicit genetic management plan is needed to guide transfer of genetic material between populations.

**185. Develop grazing plans for sites utilized by livestock.**

At sites currently grazed by cattle, prudent management is probably to continue with grazing while monitoring its effects to allow grazing with minimal negative effects on the lily. It might be beneficial to suspend

grazing, when practicable, during the lily flowering and fruiting season.

**186. Develop plans to reduce threats from deer, insects, and disease.**

The very small sizes of some populations and the apparent abundance of deer may make anti-deer management measures necessary. Similarly, insect predation and fungal infections have been observed as problems. Control measures should be developed as part of site-specific management plans only after monitoring demonstrates the existence of a problem.

**19. Evaluate Status and Trends.**

All management actions should be monitored and changes in management direction made, when necessary (Pavlik 1994, 1996). Population status and trends should be tracked by a unified and standardized, if not centralized, monitoring program that gathers annual information on total numbers and vital rates. Particularly important data, such as the total adult population and reproductive effort, should be obtained for all sites (where landowner allows) during each flowering season. Additional data, such as total surviving fruit set, rates of seedling recruitment, total population, stage- or age-specific survival rates, and the interval between seedling establishment and somewhat larger juvenile size classes should be obtained for some key sites (e.g., Table Bluff and Bastendorff Bog where vegetation management is ongoing).

**191. Conduct demography studies.**

To provide insights into what life history stages most limit population growth, and how best to facilitate rapid population growth, demographic studies should be conducted on a small number of populations selected to represent different parts of the range, and different ecological circumstances (Pavlik 1994). Comparative demographic studies are also called for in cases where major habitat manipulation is instituted.

In a recent review of a large number of recovery plans for plants, a group of academic botanists argued strongly that demographic studies are necessary to accurately assess population trends and the underlying biological bases, and should form a central part of any recovery effort (Schemske et al. 1994). Such studies are, however, extremely time consuming to conduct, and the reliability of future population growth projections is limited to the degree that the time interval studied is representative of future environmental conditions. Given that many western lily populations are in dense vegetation, such studies could probably not be conducted at some sites without serious risk of disturbing the populations being studied.

**192. Develop and implement monitoring protocols.**

Less resource-intensive monitoring methods than formal demographic studies will be required for the majority of populations. For monitoring to be most valuable, there have to be clear management objectives toward which explicit monitoring objectives can be generated, and monitoring plans created (Pavlik 1994, 1996). The most basic management objectives are to know if and when the population size requirements for downlisting have been met, or whether a population is declining so that timely and appropriate actions can be taken. To answer the question of whether there are enough populations of sufficient size, which are stable or increasing, it will be necessary to have reliable information on population sizes and trends (Pavlik 1994). Monitoring is important not only to establish population sizes, it can also provide critical information about how various management actions affect population growth and structure.

To compare different populations, a single range-wide western lily monitoring protocol must be adopted so that the data used to track the

status of western lily recovery are both meaningful in themselves, and comparable across populations. A draft modeling protocol developed by Imper in 1985 (Appendix 2) has been used on seven populations in California and at least six populations in Oregon since 1994.

Briefly, Imper's protocol describes a hierarchical array of five monitoring levels, with six additional options described (Appendix 2). Imper's protocol also includes a description of methods and an offer of initial training. The monitoring levels are broken into two main groups depending on land accessibility. If land is not accessible to monitoring parties, the only method available is simple observation from adjacent public or other land where permission for access has been granted. Where landowner permission for access is available, the monitoring levels are additive. The most basic is to complete a flowering plant census. The next level is to establish a fixed baseline and grid sufficient to map flowering lilies and establish the outer limits of the population. If resources permit, a complete population census can be added, with information recorded on additional parameters such as flower number, plant height and so on. Finally, vegetation monitoring may be combined with any of the above mentioned levels of monitoring. Additional monitoring options include gathering information on grazing impacts, fruit census in September or October, conducting systematic searches for new plants, planting a portion of the seed in suitable habitats, and finally monitoring depth to the water table with piezometers. Other environmental monitoring is also described.

The Service should evaluate Imper's protocol and work with it to establish a single protocol for obtaining data on population size and trends that are necessary to evaluate the status of the species and the course of recovery. The Service should set management and monitoring objectives. The most obvious management objectives are to maintain stable or growing populations of plants in each management area. In order to know whether

this objective has been reached at each management area, annual census figures should be obtained if feasible. When populations become large or if habitat becomes excessively complex, lily censuses are no longer feasible. In that case, a sampling plan for large populations should be adopted that will provide a protocol for monitoring, including standards for the probability of detecting a level of change in density of western lily between any two years, with the understanding that there is some probability of detecting a change, when none in fact occurred.

To aid in the evaluation of any experimental manipulation of western lily populations or their habitat, monitoring should begin before the disturbance is created.

**2. Off-site conservation.**

It is important to collect and bank seeds to use for augmentation or reintroductions in the future should they become necessary in case local populations are severely depleted or extirpated. The time to collect seed and learn how to use it to establish or augment populations is while donor populations can still sustain the collecting pressure without unduly harming their survival prospects, and before the samples are needed.

**21. Bank seeds.**

Genetically representative seed samples must be collected from as many populations as possible, in a way that does not significantly reduce the viability of donor populations in the short-term. The samples should be maintained at an established seed bank in accordance with established standards. To reduce the chance of catastrophic loss, a subsample of seeds from each population should be maintained at a second such institution.

The Berry Botanic Garden Seed Bank for Rare and Endangered Plants of the Pacific Northwest (Portland, Oregon) currently has western lily seed collected from a small number of populations, mostly from near the northern and southern limits of the species range. Genetically representative seed samples should be

obtained from all known populations. The Center for Plant Conservation's Genetic Sampling Guidelines for Conservation Collections of Endangered Plants (Center for Plant Conservation 1991) can be used as a preliminary guide to what constitutes a minimum collection. Additional collection must be done so that all extant populations have adequate material stored in the Berry Botanic Garden Seed Bank.

**22. Conduct reintroduction and augmentation studies.**

Recovery must focus primarily on protection and management of existing natural populations for their demographic vigor and genetic integrity. However, since full recovery of the species may be very difficult to achieve completely by natural expansion of existing populations on-site, reintroduction or augmentation of populations may be essential. Also, because they are small, some populations face a significant risk of random extirpation. By establishing or augmenting populations differing in size and stage-structure, it may be possible to increase the rate of population growth and genetic diversity to the point where populations and metapopulations can be considered viable (Guerrant 1996). Reintroduced populations may have considerable value as experimental surrogates from which we can learn how to manage natural populations, as has been demonstrated by Pavlik (1995). It is prudent to learn how to reintroduce and augment populations before an indisputable need arises.

Reintroduction is an emerging discipline, and as such the accompanying terminology and rationale for its appropriate use are not yet well established. There are, however, two new books that deal with various aspects of reintroduction (Bowles and Whelan 1994, Falk et al. 1996). As they are used in this plan (as opposed to those books), the terms reintroduction and augmentation are defined as follows: *Reintroduction* refers to the attempt to establish a new population where one does not currently exist; *Augmentation* refers to the attempt to increase the size of an extant population, by addition of individuals. Criteria to

aid in the decision of when and where the use of reintroduction, in the broad sense, might be appropriate have been reviewed and organized by Falk et al. (1996).

Currently, there are two ongoing efforts to learn how to establish populations from seed samples taking place near the northern and southern limits of the western lily's range. They should be encouraged. However, reintroduction is not a well-established discipline. One of the few points of consensus at a 1993 conference on reintroduction sponsored by the Center for Plant Conservation, is that reintroduction is necessarily experimental, and that short-, and especially long-term success, is far from assured (Falk et al. 1996). Consequently, reintroduced populations are not to "count" toward species recovery until scientific consensus suggests that reintroduced populations are, in general, viable, and monitoring or demographic studies show these populations in particular to be viable. Pavlik (1996) suggested a framework for evaluating success of reintroduction that involves three basic areas: number, extent, and resilience of the reintroduced population. Thus, before a population can be considered viable, it must not only grow in numbers and area covered, it must also demonstrate resilience to environmental disturbance. Finally, any reintroductions should be performed as locally as possible, to maximize their chances of success, and to maintain the gene pool of neighboring natural populations as pure as possible. The genetic effective population sizes ($N_e$) can be increased by artificially augmenting genetic migration through manual transfer of pollen, seed or small plants among adjacent populations.

Suitable regions for reintroduction need to be surveyed in both Oregon and California. In Oregon, the New River Area of Environmental Concern (Bureau of Land Management) and neighboring public areas (such as Bandon and Floras Lake State Parks) offer some areas of apparently optimal early-successional wetland habitat, as well as larger areas of late-successional but reclaimable wetland habitat which are likely ideal for the reintroduction of the lily. Other suitable sites occur on the Elk River marine terrace between Capes Arago and Blanco, but most are on

private land.

**3. Conduct and encourage public outreach.**

Western lily is protected on private land more by being a wetlands plant than it is by being endangered (see page 17). It is important for members of the public to understand the roles of both the Clean Water Act and the Endangered Species Act. The Service should use whatever means are at its disposal to inform the public about the status of the western lily and the need for conservation and stewardship of ecosystems and native species. In addition to providing information to the general public, outreach efforts should also focus on private landowners with populations of western lily on their property. Conservation agreements, stewardship agreements or other voluntary arrangements that would facilitate the protection, conservation or management of lily populations should be developed for this important group. These agreements could be made directly with the U.S. Fish and Wildlife Service or through the California Department of Fish and Game. The potential role of local colleges and universities in providing vegetation management information to private landowners should also be explored.

In this time of dwindling resources devoted to endangered species recovery (from an already low level), successful recovery of the western lily will greatly benefit from the active participation of well-meaning members of the public. Interested members of the public can contribute to the recovery of western lily by providing assistance in monitoring individual populations, and in the search for new populations. The Service should encourage and work cooperatively with private groups working to preserve our common heritage, such as the Native Plant Societies in California and Oregon.

Because of its beauty and geographical location, the western lily offers the opportunity to the Service and other interested parties to develop a range-wide campaign whereby an endangered plant can become a source of civic and regional pride, and provide a means to increase appreciation in the unique character of the region it inhabits.

Western lily recovery also affords an opportunity to undertake joint efforts with the State of Oregon Parks and Recreation Department to develop and establish

educational displays for the populations on their land. Also, brochures on the western lily should be developed for use by a wide variety of agencies involved in the western lily conservation, including but not limited to State Parks, California Department of Fish and Game, Oregon Department of Agriculture, Oregon Department of Transportation, and The Army Corps of Engineers.

To reduce the amount of incidental "taking" of plants and seeds by collectors, lily bulb producers could propagate this species for sale. To obtain permits to sell bulbs in interstate commerce, the nurseries would have to demonstrate that their propagation stock was legally obtained. There should be no difficulty obtaining such stock. Intrastate commerce is regulated by the states and requires no Federal permits. The availability of legal sources should be advertised, perhaps as part of the civic program alluded to above. Making it possible for local nurseries to sell western lily plants, and thus derive economic benefit from a local endangered species, could help reduce local hostility to the Endangered Species Act in general, provide much needed income to small local businesses in the area, as well as reducing the pressure of collectors on wild populations. There are, of course, potential risks to wild populations of western lily from such a program. For example, well-meaning people might release non-local, poorly adapted genotypes into wild populations, potentially reducing the survival probability of the wild populations. Nevertheless, these and other potential problems could be described in a pamphlet to be given to all who purchase such plants. If such a program were instituted, it would be important for an informational pamphlet describing the western lily, its plight, and its horticultural care to be developed and provided without cost to growers to pass out with plants sold.

The nascent effort to establish a range wide monitoring protocol and find volunteers to monitor specific populations over the years also offers an opportunity for the Service to gather data on population size and status at minimal cost, and help build bonds of common purpose with the public. This should be encouraged.

## LITERATURE AND REFERENCES CITED


Ayensu, E. S. and R. A. DeFilipps. 1978. Endangered and Threatened Plants of the Unites States. Smithsonian Institution and the World Wildlife Fund, Inc. Washington DC.

Ballantyne, O. 1980. A preliminary study of *Liliums bolanderi, occidentale, vollmeri,* and *wigginsii*. Unpublished report submitted to the U.S. Fish and Wildlife Service, Portland, OR.

Bowles, M. L. and C. J. Whelan (eds.). 1994. Restoration of endangered species. Conceptual issues, planning, and implementation. Cambridge Univ. Press, Cambridge. 394 pp.

Bradshaw, A. D. 1972. Some of the evolutionary consequences of being a plant. Evolutionary Biology 5: 25-47.

Center for Plant Conservation. 1991. Genetic Sampling Guidelines for Conservation Collections of Endangered Plants. *In* Falk, D. A. and K. E. Holsinger (eds.). Genetics and Conservation of Rare Plants. Oxford Univ. Press. New York.

Falk, D. A., C. I. Millar, and M. Olwell (eds.) 1996. Restoring Diversity: Strategies for Reintroduction of Endangered plants. Island Press, New York.

Guerrant, E. O. Jr. 1996. Designing populations: Demographic, Genetics, and Horticultural Dimensions. *In* Falk, D. A., C. I. Miller, and M. Olwell (eds.). Restoring Diversity: Strategies for Reintroduction of Endangered plants. Island Press, New York.

Heslop-Harrison, J. 1964. Forty years of genecology. Advances in Ecological Research 2:159-247.

Imper, D. 1987a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1987b. Monitoring plan: Western lily. Johnson Site; initiated 1986.

Imper, D. 1988a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1988b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1988c. Western lily monitoring report for the Christensen site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1989a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1989b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1989c. Western lily monitoring report for the Christensen site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1990a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1990b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1991a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1991b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1992a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1992b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1993a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1993b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1994a. Western lily monitoring report for the Johnson site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. 1994b. Western lily monitoring report for the Barry site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Imper, D. K., G. E. Hovey, J. O. Sawyer, and S. A. Carlson. 1987(December). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. Management Plan. Unpublished Report Prepared under Interagency Agreement C-1582.2. California State University. California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer. 1988 (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1989 Monitoring Report, Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/ California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer. 1990 (March). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1989 Monitoring Report, Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/ California Department of Fish and Game. 7 pages, plus figures, tables and maps.

Imper, D. K., and J. O. Sawyer. 1990 (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1990 Monitoring Report, Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/ California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer. 1991 (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1991 Monitoring Report, Western Lily. Unpublished Report Prepared under Interagency

Agreement. California State University/ California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer. 1992a (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1992 Monitoring Report, Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/ California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer. 1992b (October). Botanical Survey of the Crescent City Marsh Wildlife Area. California Department of Fish and Game, Del Norte County, California. Unpublished report Prepared Under Interagency Agreement, California State University/California Department of Fish and Game. 33 pages and 2 appendices.

Imper, D. K., and J. O. Sawyer. 1993 (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1993 Monitoring Report, Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/ California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer. 1994a (March). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1993 Status Report: Experimental Habitat Manipulation, Western Lily Habitat. Unpublished Report Prepared under Interagency Agreement. California State University/California Department of Fish and Game.

Imper, D. K., and J. O. Sawyer, 1994b (October). Table Bluff Ecological Reserve: California Department of Fish and Game, Humboldt County, California. 1994 Monitoring Report Western Lily. Unpublished Report Prepared under Interagency Agreement. California State University/California Department of Fish and Game. With 2 attachments.

Kline, B, 1984. Cultivating West coast lilies. Journal of the North American Lily Society. 38(3): 11-13

Lande, R. 1995. Mutation and conservation. Conservation Biology. 9(4): 783-791

Levin, D.A. 1979. The nature of plant species. Science 204: 381-384.

Levin, D.A. 1981. Dispersal versus gene flow in plants. Annals of the Missouri Botanical Garden. 68: 233-253.

Levin, D. A. 1993. Local speciation in plants: the rule not the exception. Systematic Botany 18: 197-208.

Levin, D.A., and H. W. Kerster. 1974. Gene flow in seed plants. Evolutionary Biology 7: 139-220.

Lozier, L. 1987 The California Nature Conservancy's landowner contact and registry program: Voluntary protection for rare plant sites. *In* Elias, T. S. (ed.). Conservation and Management of Rare and Endangered Plants. California Native Plant Society, Sacramento. Pages 567-571.

Lozier, L. 1995. Making contact: Working with people who aren't like you. Fremontia 23(2): 8-13.

Lynch, M, J. Conery, and R. Bürger. 1995. Mutation accumulation and the extinction of small populations. American Naturalist. 146(4): 489-518.

McRae, J. 1991. Western lily monitoring report for the Christensen site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

McRae, J. 1992. Western lily monitoring report for the Christensen site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

McRae, J, and D. Imper. 1990. Western lily monitoring report for the Christensen site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

McRae, J, and D. Imper. 1993. Western lily monitoring report for the Christensen site, Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

McRae, J, and D. Imper. 1994. Western lily monitoring report for the Christensen site,

Table Bluff, California. Unpublished report submitted to The Nature Conservancy, Arcata, CA.

Pavlik, B.M. 1994. Demographic monitoring and the recovery of endangered plants. *In.* M. Bowles and C. Whelan (eds.). Restoration of Endangered Species. Conceptual issues, planning, and implementation. Cambridge Univ. Press, Cambridge.

Pavlik, B.M. 1995. The recovery of an endangered plant II. A three-phased approach to restoring populations. *In* Urbanska, K. M., and K. Grodzinska (eds.) Restoration ecology in Europe. Geobotanical Institute SFIT, Zürich. pp 49-69.

Pavlik, B. 1996. Defining and measuring success in rare plant reintroductions. *In* Falk, D. A., C. I. Millar, and M. Olwell (eds.). Restoring Diversity: Reintroducing endangered plants to the landscape,. Island Press, New York.

Purdy, C. 1897. New west American lilies. Erythea. 5(9): 103-105

Raven, P. H. 1986. Modern aspects of the biological species in plants. *In* Iwatsuki K., P. H. Raven, and W J. Bock. Modern Aspects of Species. Tokyo University Press, Tokyo.

Rittenhouse, B. 1994. 1994 Western Lily Monitoring Report for Populations at Shore Acres State Park, Hauser, Morrison Road, and New River. Prepared by Bruce Rittenhouse, BLM. Coos Bay District Office.

Rittenhouse, B. 1995. 1995 Western Lily Monitoring Report for Populations at Hauser, Shore Acres State Park, Morrison Road, and New River Area of Critical Environmental Concern. Prepared by Bruce Rittenhouse, Bureau of Land Management, Coos Bay District Office.

Salzer, D. 1994. Monitoring *Western lily* at Bastendorff Bog from 1985 to 1993. Unpublished summary, information presented LIOC meeting at Berry Botanic Garden February 1994. ["unpublished summary"]

Schemske, D. W, B. C Husband, M. H Ruckelshaus, C. Goodwillie, I. M. Parker, and J. G. Bishop. 1994 Evaluating approaches to the conservation of rare and endangered

plants. Ecology. 75(3): 584-606.

Schultz, S. T. 1989 (September). Status Report on *Lilium occidentale* Pard. Unpublished report prepared for the Endangered Species Program, Plant Division, Oregon State Department of Agriculture, Salem, Oregon.

Siddall, J. L., and K. L. Chambers. 1978. Status report on *Lilium occidentale*. Unpublished report, Oregon Rare and Endangered Plant Project. Lake Oswego, OR.

Skinner, M. W. 1988 (June). Comparative Pollination Ecology and Floral Evolution in Pacific Coast *Lilium*. Unpublished thesis. Harvard University, Cambridge, MA.

Skinner, M. W. 1993. *Lilium*. Lily. *In* J. C. Hickman (ed.). The Jepson Manual: Higher Plants of California. University of California Press, Berkeley. pp 1198-1201.

Skinner, Mark W. and Bruce M. Pavlik. (eds.) 1994. California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California. California Native Plant Society Special Publication No. 1/ fifth edition.

Sobrevila, C. 1988. Effects of distance between pollen donor and pollen recipient on fitness components in *Espeletia schultzii*. American Journal of Botany. 75:701-724.

Waser, N. M., and M. V. Price. 1989. Optimal outcrossing in *Ipomopsis aggregata*: Seed set and offspring fitness. Evolution. 43: 1097-1109.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants. Endangered status for the plant *Lilium occidentale* (western lily). Federal Register 59: 42176. August 17.

## IMPLEMENTATION SCHEDULE

The implementation schedule that follows outlines actions and estimated costs for the western lily recovery program. It is a *guide* for meeting the objectives discussed in Part II of this plan. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, the agencies responsible for committing funds, and lastly, estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one agency is listed as the responsible party, an asterisk is used to identify the lead entity.

The actions identified in the implementation schedule, when accomplished, should protect habitat, stabilize populations, and hopefully lead to delisting of this species. Monetary needs for all parties involved are identified to reach this point.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Key to Acronyms used in Implementation Schedule

BLM - Bureau of Land Management

CDFG - California Department of Fish & Game

FWS - U.S. Fish and Wildlife Service.

ODA - Oregon Department of Agriculture

ODOT - Oregon Department of Transportation

ODPR - Oregon Department of Parks & Recreation

ONHP - Oregon Natural Heritage Program

ORTNC - Oregon Chapter, The Nature Conservancy

CATNC - California Chapter, The Nature Conservancy. Landowner contact program.

ND - Not Determinable at this time

* - Lead Agency

## Implementation Schedule for Western Lily Recovery Plan

| Priority | Task No. | Task Description | Duration (years) | Responsible party | Total cost | Cost estimates ($1,000) 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | **Locate all known sites** | 1 | FWS* | 5 | 5 | | | | | | | | | |
| | | | | CDFG | 5 | 5 | | | | | | | | | |
| | | | | ODA | 5 | 5 | | | | | | | | | |
| | | **Locate New Sites** | | | | | | | | | | | | | |
| 1 | 121 | Characterize habitat of existing sites | 1 | FWS* | 5 | | 5 | | | | | | | | |
| | | | | CDFG | 5 | | 5 | | | | | | | | |
| | | | | ODA | 5 | | 5 | | | | | | | | |
| 1 | 122 | Identify potential habitat | 1 | FWS* | 6 | | | 6 | | | | | | | |
| | | | | CDFG | 3 | | | 3 | | | | | | | |
| | | | | ODA | 3 | | | 3 | | | | | | | |
| | | | | BLM | 3 | | | 3 | | | | | | | |
| 1 | 123 | Search for additional sites and potential habitat | 1 | FWS* | 6 | | | 6 | | | | | | | |
| | | | | CDFG | 3 | | | 3 | | | | | | | |
| | | | | ODA | 3 | | | 3 | | | | | | | |
| | | | | BLM | 3 | | | 3 | | | | | | | |
| 1 | 13 | Determine patterns of genetic diversity | 2 | FWS* | 20 | | | | 10 | 10 | | | | | |
| | | | | CDFG | 20 | | | | 10 | 10 | | | | | |
| | | | | ODA | 20 | | | | 10 | 10 | | | | | |
| 1 | 14 | Prioritize recovery populations | 1 | FWS* | 0.5 | | | | | | | 0.5 | | | |
| | | | | CDFG | 0.5 | | | | | | | 0.5 | | | |
| | | | | ODA | 0.5 | | | | | | | 0.5 | | | |
| | | | | BLM | 0.5 | | | | | | | 0.5 | | | |

| Priority | Task No. | Task Description | Duration (years) | Responsible party | Total cost | Cost estimates ($1,000) 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ODPR | 0.5 | | | | | | | 0.5 | | | |
| | | | | ODOT | 0.5 | | | | | | | 0.5 | | | |
| 1 | 15 | Delineate boundaries of Management Areas | 1 | FWS* | 5 | | | | | | | | 5 | | |
| | | | | CDFG | 5 | | | | | | | | 5 | | |
| | | | | ODA | 5 | | | | | | | | 5 | | |
| 1 | 16 | Secure the delineated management areas | 10 | FWS* | ND | | | | | | | | ND | ND | ND |
| | | | | ORTNC | ND | | | | | | | | ND | ND | ND |
| | | | | CDFG | ND | | | | | | | | ND | ND | ND |
| | | **Conduct Research on ways to Reduce Threats** | | | | | | | | | | | | | |
| 2 | 171 | Conduct research on vegetation control methods | 3 | FWS* | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | ODA | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | CDFG | 30 | 10 | 10 | 10 | | | | | | | |
| 2 | 172 | Conduct genetic studies | 3 | FWS* | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | ODA | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | CDFG | 30 | 10 | 10 | 10 | | | | | | | |
| 2 | 173 | Conduct research on effects of small & large mammal herbivory | 3 | FWS* | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | ODA | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | CDFG | 30 | 10 | 10 | 10 | | | | | | | |
| 2 | 174 | Conduct research on Insect herbivory & microbial rot control measures | 3 | FWS* | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | ODA | 30 | 10 | 10 | 10 | | | | | | | |
| | | | | CDFG | 30 | 10 | 10 | 10 | | | | | | | |

| Priority | Task No. | Task Description | Duration (years) | Responsible party | Total cost | Cost estimates ($1,000) 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Manage sites to stabilize and/or enhance lily, utilizing site-specific plans** | | | | | | | | | | | | | |
| 2 | 181 | Characterize existing conditions | 1 | FWS* | ND | | | | | | | | | | |
| | | | | ODA | ND | | | | | | | | | | |
| | | | | CDFG | ND | | | | | | | | | | |
| | | | | OHNP | ND | | | | | | | | | | |
| | | | | BLM | ND | | | | | | | | | | |
| 2 | 182 | Develop site history | 1 | FWS* | ND | | | | | | | | | | |
| | | | | ODA | ND | | | | | | | | | | |
| | | | | CDFG | ND | | | | | | | | | | |
| | | | | CATNC | ND | | | | | | | | | | |
| | | | | ODOT | ND | | | | | | | | | | |
| | | | | ODPR | ND | | | | | | | | | | |
| | | | | ONHP | ND | | | | | | | | | | |
| 2 | 183 | Control woody vegetation | | FWS* | ND | | | | | | | | | | |
| | | | | BLM | ND | | | | | | | | | | |
| | | | | CDFG | ND | | | | | | | | | | |
| | | | | ODA | ND | | | | | | | | | | |
| | | | | ODOT | ND | | | | | | | | | | |
| | | | | ODPR | ND | | | | | | | | | | |
| | | | | OTNC | ND | | | | | | | | | | |

| Priority | Task No. | Task Description | Duration (years) | Responsible party | Total cost | Cost estimates ($1,000) 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 184 | Develop augmentation plan | 2 | FWS* | ND | | | | | | | | | | |
| | | | | BLM | ND | | | | | | | | | | |
| | | | | CATNC | ND | | | | | | | | | | |
| | | | | CDFG | ND | | | | | | | | | | |
| | | | | ODA | ND | | | | | | | | | | |
| | | | | ODOT | ND | | | | | | | | | | |
| | | | | ODPR | ND | | | | | | | | | | |
| | | | | ONHP | ND | | | | | | | | | | |
| 2 | 185 | Develop grazing plans for sites used by livestock | 1 | FWS | ND | | | | | | | | | | |
| | | | | ODA | ND | | | | | | | | | | |
| | | | | ONHP | ND | | | | | | | | | | |
| | | | | CATNC | ND | | | | | | | | | | |
| 2 | 186 | Develop plans to reduce threats from deer, insects, and disease | 1 | FWS* | ND | | | | | | | | | | |
| | | | | ODA | ND | | | | | | | | | | |
| | | | | CATNC | ND | | | | | | | | | | |
| | | | | CDFG | ND | | | | | | | ND | ND | ND | ND |
| | | | | ONHP | ND | | | | | | | ND | ND | ND | ND |
| | | | | ODOT | ND | | | | | | | ND | | | |
| | | | | OTNC | ND | | | | | | | | | | |
| | | | | ODPR | ND | | | | | | | ND | | | |
| | | | | BLM | ND | | | | | | | ND | | | |
| | | **Evaluate Status & Trends** | | | | | | | | | | | | | |
| 2 | 191 | Conduct demography studies | 10 | FWS* | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | | ODA | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | | CDFG | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | | ONHP | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

| Priority | Task No. | Task Description | Duration (years) | Responsible party | Total cost | Cost estimates ($1,000) 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 192 | Develop & implement monitoring protocols | O | FWS* | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | | ODA | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | | CDFG | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | | ONHP | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | **Cost for need 1: On-Site Conservation** | | | **1298** | **215** | **215** | **215** | **95** | **110** | **113** | **95** | **80** | **80** | **80** |
| 2 | 21 | Bank seeds | 5 | FWS* | 5 | 1 | 1 | 1 | 1 | 1 | | | | | |
| | | | | Berry Garden | 25 | 5 | 5 | 5 | 5 | 5 | | | | | |
| 3 | 22 | Conduct reintroduction & augmentation studies | ND | FWS* | ND | ND | | | | | | | | | |
| | | | | ODA | ND | ND | | | | | | | | | |
| | | | | CDFG | ND | ND | | | | | | | | | |
| | | | | ONHP | ND | ND | | | | | | | | | |
| | | **Cost for need 2: Off-site conservation** | | | | **6** | **6** | **6** | **6** | **6** | **0** | **0** | **0** | **0** | **0** |
| 3 | 3 | Public outreach | O | FWS | 50 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | | **Cost for need 3: Public outreach** | | | **50** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** | **5** |
| | | **Total Cost** ..... | | | **1378** | **226** | **226** | **226** | **106** | **121** | **118** | **100** | **85** | **85** | **85** |

**Appendix 1: Site specific threats and recommended responses.**

**Hauser** (Private, State of Oregon Department of Transportation)

The wetland consists primarily of a dense stand of *Spiraea douglasii* approximately two meters in height, with associated *Ledum glandulosum, Gaultheria shallon, Rubus ursinus, Pteridium aquilinum, Juncus* spp., *Anaphalis margaritacea, Blechnum spicant, Vaccinium ovatum,* and encroaching *Chamaecyparis lawsoniana, Pinus contorta, Picea sitchensis, Salix* spp., *Myrica californica,* and *Cytisus scoparius.* No *Calamagrostis nutkaensis* occurs near the lily, although some individuals grow along the highway here. A small *Darlingtonia californica* population was reported here in the past.

Browsing by deer or other herbivores appears to have been rare at this site at least in recent years (due perhaps to the close proximity of a road), as indicated by successful fruit production by most adults each year, which typically produce over two (and up to seven) capsules per individual.

Although in the past more widely distributed in this site, western lily currently occurs almost entirely in a small enclave measuring roughly five by five meters near the southeastern edge of the wetland, where *Spiraea* growth is low and sparse. The area now occupied by the lily population is less than 1/50 of the total wetland.

The primary threat here is natural succession, as indicated by the disappearance of several adult lilies from the northern portion of the wetland over the last decade, caused probably by competition from *Spiraea.* Several trees have also recruited into the wetland recently, all of which are under six meters in height.

**Recommendations**. This site should be publicized within the appropriate state agencies as an Oregon Department of Transportation Special Management Area. U.S. 101 should not be widened here, or otherwise altered or its shoulder sprayed, mowed, or ditched without prior consultation with knowledgeable parties.

The minimal response to the threat of succession should be the manual removal (1) of all conifers, *Salix,* and *Myrica* from the interior of the wetland, and (2) of all *Spiraea* from within five meters of each adult lily. The dense stand of *Pinus contorta* bordering the lily population on the east lies on private land, and should remain intact to limit access to and visibility of the population.

The full recovery of the lily population and its spread throughout this wetland will require removal of *Spiraea* over large areas. A range of options for the control of this

species should be investigated, included the feasibility of a controlled burn at this small site, which could eventually support several hundred adults.

**Bastendorff** (Private, The Nature Conservancy)

In 1860, this site was mapped as a prairie that extended unbroken from Yoakum Point westward to Sunset Bay. This open area was bounded on the west and east by villages of Coos Indians. In the early and mid-1900s the area was known as Mussel Reef Bog, named after the reef at Yoakum Point. This bog was virtually treeless prior to 1960, after which over 90% of the currently standing conifers recruited. There is evidence of recent fires in the north forest margin, but the lack of any woody debris in the bog interior indicates the absence of a forest here for at least the last two centuries.

Secondary succession over the last 50 years has nearly eliminated the previous bog habitat at Bastendorff. The current vegetation community is dominated by dense, often tall stands of *Gaultheria shallon, Myrica californica*, and *Vaccinium ovatum*, with remnant *Ledum glandulosum, Sphagnum, Darlingtonia californica, Xerophyllum tenax, Gentiana sceptrum, Vaccinium uliginosum, Tofieldia glutinosa*, and other species of the former bog. In addition to aggressively encroaching *Gaultheria* and *Myrica*, several invading tree species (*Chamaecyparis lawsoniana, Thuja plicata, Picea sitchensis*, and *Rhamnus purshiana*) have begun to close the canopy along the margins of the bog and in scattered places in the interior. This succession has restricted the formerly large western lily population here to a few small remnant enclaves (less than 1/100 of the total wetland area) where competing vegetation is low and sparse. Succession has resulted in a drop in mean number of flowers produced per adult individual from 1.2 to 1 from 1985 to 1995.

In addition to competitive stress, browsing by deer, elk and possibly small mammals eliminates roughly 10 percent to >50 percent of reproduction each season.

**Recommendations.** The minimal response to the successional threat is the regular manual removal of all aboveground vegetation within the existing lily enclaves, with the objective of increasing the current population to the extent allowed by the remaining habitat (capable of eventually supporting probably not more than 100-200 adult plants). The initial clearing performed here in February 1994 should be followed by annual monitoring of the total adult population, juvenile recruitment into standardized quadrats within the cleared areas, the rate of encroachment of competing vegetation, and the frequency of mammal browsing. Fencing options for deer control should also be reviewed.

The feasibility of a controlled burn here needs investigation; concerns include the proximity of residential dwellings along the west property margin, the need to minimize

human access to and visibility of the area, and the inclusion of the wetland within at least two ownerships, The Nature Conservancy and the State of Oregon (Department of Parks and Recreation, Sunset Bay State Park). A controlled understory burn, combined with girdling of established large trees, are probably the only means of reclaiming the total available lily habitat at this site. This should allow spread and increase of the current population by over an order of magnitude. An initial test burn on a portion of the population might provide needed evidence on the efficacy of fire as a management tool in the recovery of western lily.

**Shore Acres** (State of Oregon)

Western lily occurs in three major concentrations on the flat oceanfront terrace south of the cove at Shore Acres State Park. This terrace was logged and then used to graze livestock owned by the Simpson family in the early to mid-1900s, and signs of disturbances remain, such as structure foundations, clearings, and exotic plants.

Although the region is now occupied primarily by low shrubs, it is succeeding quickly from east to west into a dense forest of *Pinus contorta* and *Picea sitchensis*. Ionic toxicity of salt spray, primarily from the sustained north-northwest winds of summer, has killed or damaged meristems on many plant species here, and slowed growth and encroachment of conifers since livestock grazing ended. However, this effect is not sufficient to prevent succession to forest, as is demonstrated in neighboring regions of the headland and on similar sites throughout the Oregon Coast north of Cape Blanco. Abundant young *Pinus* and *Picea* occur throughout the terrace, and growth is fast in individuals in the lee of established trees.

(1) The northern concentration occurs in a disturbed area among *Gaultheria shallon, Calamagrostis nutkaensis, Pteridium aquilinum, Daucus carota, Polystichum munitum, Achillea millefolium, Rubus ursinus, Dactylis glomerata, Lonicera involucrata, Picea sitchensis, Alnus rubra, Myrica californica, Vaccinium ovatum*, and some *Crataegus* and *Berberis darwinii*. For the last 20 years the area has been well sheltered by a stand of *Picea sitchensis* from winds of both summer and winter, and succession since that time has been rapid. The largest trees nearby include an *Alnus rubra* 10 years old, 0.2 meters diameter at breast height (dbh), and approximately eight meters tall; and a *Picea sitchensis* 16 years old, 0.25 meters dbh, and approximately 10 meters tall. Shrub growth here is dominated by *Lonicera involucrata* and *Myrica californica*, which often reach three to four meters in height, and have limited the occurrence of the lily to low areas along the trails and human clearings.

(2) Since the central or main site is directly exposed to winds off the ocean, most woody vegetation remains less than two meters in height, and salt spray damage is evident especially on new growth of *Lonicera involucrata*. The site is dominated by low *Gaultheria* and *Calamagrostis*, and scattered patches of *Lonicera, Myrica, Ilex*, and *Picea* that reach nearly two meters.

(3) Vegetation at the southern site is similar to that at the main site, and is dominated by *Calamagrostis* and low *Gaultheria. Myrica* and *Lonicera* are encroaching along the margins, where they have reached two meters in height, and some *Picea* is beginning to encroach from the east.

**Recommendations.** The minimal response to succession at all three sites should be the elimination of all conifers and *Alnus* closer than approximately 10 meters from all lilies, and the removal or pruning to less than one meter in height of all neighboring *Lonicera, Myrica, Ilex*, and *Berberis*. Some tall shrub buffer between the lilies and the neighboring footpaths should be left intact to limit human access to and visibility of these populations. Also, depredation of adult lilies by deer and/or humans is frequent and sometimes devastating at all three sites. Investigation of the source of this damage is needed, as well as options for deer exclusion and more effective enforcement of "take" laws. Most of the approximately 200 x 50 meter headland terrace scrub habitat here is suitable for the western lily, and expansion of the existing populations should be mechanically easy over the large areas of sparse vegetation, which could probably support over 1,000 adults.

Manual vegetation removal was begun at the Shore Acres site in 1995. The extent of removal should be documented, and response of western lily plants should be monitored. More removal may be in order.

**New River** (Bureau of Land Management)

This population consists of only two known adult plants. It appears to occupy a small ridge of excellent habitat for western lily between two abandoned cranberry bogs. Its status needs additional investigation. Suitable habitat for western lily is abundant nearby in the New River Area of Ecological Concern, which eventually could support a population of several thousand adults. This property should be surveyed for natural populations, as well as for potential sites for establishment of new populations.

**Morrison Road** (Private)

This population occurs in a relatively dry, disturbed area beneath power lines. Vegetation is a mixture of introduced grasses with scattered shrubs and young conifers. Dominant species include *Gaultheria shallon, Pteridium aquilinum, Xerophyllum tenax, Vaccinium ovatum, Rubus ursinus*, and *Juncus*. Encroaching trees and shrubs are primarily *Pinus contorta, Thuja plicata, Chamaecyparis lawsoniana*, and *Ulex europaea*. There a large number of problems at this site, including deformed flowers, and an apparent fungal infection of flowers and fruits. There may also be hybridization with the more common *Lilium columbianum*.

**Recommendations.** A cooperative agreement is needed among private landowners and agencies responsible for maintaining the utility corridor and those responsible for recovery of the western lily. This agreement should ensure the regular removal of conifers and *Ulex* from the vicinity of the lily population outside of the flowering season and in a manner non-damaging to soil and bulbs. Browsing apparently by deer, has been severe, and investigation of measures for their exclusion are needed.

**Bowman 1** (Private)

A single natural population of western lily has survived in the back garden of a residence in Bandon. Succession was manually prevented at this site from the 1930s until 1990, when the elderly owners moved and transferred ownership to a daughter who is unable to maintain the site. The population has consequently fallen as *Pinus contorta* and *Ulex europaea* have aggressively invaded. Survival of this population will require removal of all recruits of these species approximately every five years.

**Old Bowman 2 and 3** (Private, two populations)

The natural population was allegedly destroyed in July 1994, and may no longer exist. Its status needs to be determined, and seeds or bulbs need to be collected for reintroduction elsewhere. Contact with and cooperation of the landowner is necessary. A cultivated population (established by seed from the Bowman population) in a different location may also persist (and was last seen in 1987), and would be an ideal seed source for reintroductions.

**Blacklock Point** (State of Oregon)

This population lies along the boundary between Curry County and the State of

Oregon (Parks and Recreation, Floras Lake State Park), in an area of low shrubs that was burned in the mid to late 1970s. The lily population occupies an area less than 1/4th of the total burn. Dominant associates include *Gaultheria, Myrica, Rhododendron macrophyllum, Vaccinium ovatum, Calamagrostis nutkaensis, Xerophyllum tenax, Ledum glandulosum, Polystichum munitum*, and *Pinus contorta*. Young *Pinus* occurs scattered throughout the burn, and the largest individuals (under five meters in height) are 16 years old. Larger individuals around the margin of the burn are 35 to 40 years old.

There are many other western lily plants scattered in surrounding habitat, especially along trails where surrounding vegetation is a threat.

**Recommendations.** The minimal response to succession should be the removal of all conifers from within approximately 10 meters of each lily individual, and removal or pruning to less than one meter of all neighboring *Myrica*. Preferably, all conifers throughout the burned area should be removed. Deer browsing of lilies is a major problem here, and fencing options should be explored.

Blacklock Point is the site locality for the Blacklock soil type, and includes over three continuous square kilometers of potentially ideal State-owned wetland habitat for the western lily. This habitat, however, can be reclaimed only by controlled burning. Investigation is needed on the feasibility of a large burn here (of approximately 120-year-old stunted *Pinus* and *Picea* forest), which could open habitat sufficient for eventual support of several thousand adult lilies. The main drawback of a burn is the attractiveness of the forest to visitors, who hike through it to the beach at Blacklock Point. Many large burns, however, could be designed out of eyesight of the main trail. Both understory and canopy burns could be more safely carried out at this site than at probably any other known western lily population, due to its isolation, the absence of neighboring developments (except for a large cranberry farm to the south), and the ocean as its western boundary.

**Rainbow Rock** (Private)

This site has become extremely overgrown, and is dominated by a continuous stand of *Spiraea douglasii* two meters in height. Other associates include *Sphagnum, Blechnum spicant, Carex, Calamagrostis nutkaensis, Ledum glandulosum, Gaultheria shallon, Lysichiton americanum, Vaccinium ovatum*, and encroaching *Myrica californica, Rhamnus purshiana, Alnus rubra, Pinus contorta*, and *Picea sitchensis*. The largest *Pinus* growing here among the lilies exceed 40 years in age and 0.25 meter dbh. The lily population now appears largely restricted to the margins of human footpaths due to dense

growth of *Spiraea*.

**Recommendations.** Contact/cooperation with the landowner is necessary. The minimal response to succession should be removal of all young conifers, *Rhamnus*, and *Alnus* from within approximately 10 meters of all lilies, and the elimination or pruning of all neighboring *Spiraea* and *Myrica* to less than one meter in height. Older conifers in the vicinity of lilies should be girdled. The total extent of the former wetland should be determined, and the feasibility of a larger-scale clearing project investigated. The extent of potentially reclaimable habitat here might be sufficient to increase the current population over an order of magnitude.

**Harris Bog** (State of Oregon)

This site is wet year around, and still contains a large *Sphagnum* population beneath a low cover of *Ledum* and *Gaultheria*. Also present are *Calamagrostis, Sanguisorba officinalis, Veratrum, Blechnum, Polystichum munitum, Juncus*, and *Lysichiton americanum*. Rapidly encroaching from the north and south are *Myrica, Alnus, Rhamnus, Salix, Rubus spectabilis*, and *Rubus discolor*.

An eight meter strip along the eastern margin of this site was destroyed during the burying of sewer lines in 1983 and 1992 and subsequent filling in with rock that was later removed. The substrate here is now compacted clay, colonized primarily by *Juncus*, and appears incapable of supporting western lily.

**Recommendations.** This site should be publicized within appropriate agencies as an Oregon Department of Transportation Special Management Area, and U.S. 101 should not be widened here, or otherwise altered or its shoulder brushed or sprayed without prior consultation with knowledgeable parties. Coded roadside posting, which could be easily interpreted by road maintenance crews, might reduce the number of accidental assaults on roadside populations. The City of Brookings should be informed of the location of the population and its new legal responsibilities regarding this endangered taxon.

The minimal response to succession should be the removal of all conifers from the site, and all encroaching *Alnus, Rhamnus, Salix*, and *Rubus*. *Myrica* should be eliminated or pruned to less than one meter in height. The opportunity for expansion of this population appears limited.

**Harris Beach State Park** (State of Oregon)

This recently discovered population is the largest known in Oregon, second only to

the Crescent City Marsh, and occurs in a large, early successional bog whose central regions remain wet throughout the summer and still contain a large *Sphagnum* population. Vegetation in the low portion, primarily to the east of the power line, is dominated by *Spiraea douglasii, Ledum glandulosum, Carex, Sphagnum, Calamagrostis nutkaensis,* and *Sanguisorba officinalis,* with scattered *Gentiana sceptrum, Aster, Veratrum, Blechnum spicant,* and *Solidago canadensis.* West of the power line the community grades into tall *Salix, Myrica californica, Pyrus [Malus] fusca, Alnus rubra, Lithocarpus densiflora,* four species of *Rubus,* and *Rhododendron macrophyllum.* This young woody community is bordered on the west, north, and south by a mature *Pseudotsuga menziesii* forest.

To the east and north of the low bog, the community has succeeded into dense, tall, *Myrica californica, Salix,* and *Pyrus fusca.*

**Recommendations.** The minimal response to succession here should be the prevention of recruitment of all *Myrica, Salix, Alnus,* and conifers into the central low bog. A possible threat is the eventual competitive exclusion of lilies by *Spiraea douglasii,* which has reached nearly two meters in height around some of the margins of the bog. This species should be manually cleared where near adult western lilies, and options for its permanent control need investigation. Flowering plants appear to be in decline along the pole corridor, so there is an immediate need for clearing. The Harris Heights development is largely cut off from the population by a wall of *Rubus* and dense *Salix,* and this buffer should remain.

In addition, a soil analysis (moisture, pH, peat content, depth to water table) of this site should be performed with the objective of defining the boundaries of the original wetland, and especially to determine its extent to the west of the power line. The current low vegetation area probably represents less than 1/4th of the total wetland, which if reclaimed, could support several times the current population of western lily. The feasibility of controlled burning to reclaim the original habitat needs study. If large areas to the west can be opened for lily habitat, clearing should commence immediately since this community is rapidly succeeding to a closed-canopy forest.

**Brookings Bog** (Private)

This community was similar to those at Harris Heights and Harris Bog, and contained probably the second largest population in Oregon (and was well known in the 1930s), with adults typically producing over two flowers (and up to 5) each year. Approximately 80 percent of the wetland on the uphill, northeast side was filled in 1989,

and developed with three homes from 1990 to 1995. Drainage into the remaining wetland was simultaneously greatly reduced by both the development and ditching. This community is dominated by *Spiraea douglasii, Ledum glandulosum, Calamagrostis nutkaensis, Juncus, Sphagnum, Sanguisorba officinalis, Blechnum spicant, Veratrum*, and *Lysichiton americanum*. Perhaps in response to less wet conditions, dense growth of *Alnus rubra* and *Salix* are moving inward, as well as *Rubus discolor* and tall *Spiraea* from the northeast.

**Recommendations.** Contact/cooperation with the landowner is necessary. The size of the remaining western lily population, and the feasibility of reclaiming this site for the lily need investigation. The property is currently advertised for sale as a homesite. The few adults seen flowering after the development are no longer apparent, and may have been removed. Though greatly altered, less than a quarter its original size, and in the center of residential Brookings, the bog still remains wet throughout the summer and supports a large *Sphagnum* population. If properly managed, it could eventually support over 100 adult lilies, and material from Harris Heights could be used to repopulate this site. In addition to natural succession, human depredation will remain an ongoing threat here.

**Point St. George** (Private)

The three more or less distinct populations on Pt. St. George are under the same ownership, which has been hostile to protective efforts in the past. Various plans for commercial development of the property have been advanced over the years, but have been stopped due to the sensitive resource issues. Cattle are grazed on two of the sites, and along with fire, may have been an important historical factor in maintaining suitable western lily habitat. Vegetation is diverse, ranging from an exceptional stand of wet coastal prairie, to moderately disturbed pasture, Sitka spruce and coastal scrub interface and freshwater scrub marsh. Dominant species commonly include *Calamagrostis nutkaensis, Spiraea douglasii, Alnus sitchensis, Ledum glandulosum, Gaultheria shallon, Myrica californica, Juncus* spp., *Carex* spp. and numerous others. Several other rare plant and animal species are present. A portion of the habitat was recently mowed by the owner during the flowering season, which appeared to have a beneficial effect on the western lily population.

**Recommendations.** The Coastal Conservancy and other interested agencies have expressed interest in acquiring this property, due to the many unique biological resource and aesthetic values. At least a portion of this property should be acquired for public

enjoyment and resource conservation. Short of acquisition, a formal cooperative agreement should be arranged with the owner, if possible. Vegetation management is urgently needed at the population located at the north end of the spruce stand, in order to control encroaching *Spiraea* and other shrubs. Appropriate measures may include fire (if feasible), controlled grazing or in the short term, manual control. Research is needed to determine if western lily is reproducing, particularly in the coastal prairie west of the road, which is not currently subject to cattle grazing.

**Crescent City Marsh Wildlife Area** (Cal. Dept. of Fish and Game) & adjacent privately owned marsh

This wetland complex, most of which occurs within the Crescent City Marsh Wildlife Area (CCMWA), contains the largest known population of western lily. The marsh also contains a diverse assemblage of freshwater marsh communities, some quite rare in California. The marsh complex is unquestionably a centerpiece of any conservation program for western lily. Occupied western lily habitat ranges from wet coastal prairie, dominated by *Calamagrostis nutkaensis* and *Deschampsia caespitosa*, to sedge marsh, and an unusual low herb marsh dominated by *Menyanthes trifoliata*. Western lily occurs in highest density in a dense scrub marsh dominated by *Ledum glandulosum* and *Calamagrostis nutkaensis*. Five other geographically isolated and smaller concentrations of western lily occur within the CCMWA or on adjacent private land. Habitat at these sites consists of wet, former pasture, an area of coastal scrub/*Carex* marsh interface, and more upland coastal prairie. Two of the smaller colonies are monitored annually; no formal monitoring of the main population has been conducted. Much of the marsh was subdivided over the past 50 years, and the very large number of owners complicates the conservation effort. Residential encroachment, timber harvest and grading, and wetland draining on parcels immediately surrounding the marsh, most of it illegal, threatens both the biological and hydrological integrity of the complex.

**Recommendations**. Removal of cattle after acquisition by the State of California allowed encroachment by *Alnus rubra, Picea sitchensis, Spiraea douglasii* and other aggressive shrubs mostly in the more upland portions of the marsh, which has impacted or will soon impact the lily. Due to the large amount of occupied habitat present, a monitoring program should be implemented that utilizes aerial photograph transects with ground verification to monitor large scale changes in vegetation. An immediate program

of sapling removal and shrub thinning should be implemented in some areas. Strict regulatory enforcement should be advocated, and other methods for protecting the remainder of the undisturbed watershed should be explored. Key privately-owned parcels both within and surrounding western lily occupied marsh should be acquired, as recommended by Imper and Sawyer (1992b).

**Crescent city (EO 30) -- spruce stand** (Private)

This small population is located within dense spruce forest at the west edge of the CCMWA. Vegetation is typical of dense spruce stands on Table Bluff occupied by western lily, and dominated by *Maianthemum dilatatum, Carex obnupta* and *Picea sitchensis*. As was the case at Table Bluff, the majority of plants are repressed, small juveniles, caused by the dense spruce cover. The canopy was partially opened two years ago, and two plants flowered this past year. The site has been subject to disturbance from nearby homeless camps in the past, but recent camping restrictions have, at least temporarily, eliminated those impacts. The site is also threatened by development immediately to the north, associated with a former bulk oil facility.

**Recommendations**. If possible, a cooperative agreement should be arranged with the owner. Surrounding marsh habitat (CCMWA) appears suitable for western lily, but is unoccupied. Moderate thinning of the overstory spruce should be beneficial to reproductive vigor of the population, without encouraging rapid development of scrub. Enhancement of this population could potentially contribute to natural expansion of the population into the surrounding marsh habitat.

**Table Bluff Ecological Reserve** (Cal. Dept. of Fish and Game)

The Table Bluff Ecological Reserve (TBER) has been managed for the benefit of western lily since acquired by the State in 1987. Past management has included annual population and vegetation monitoring, exclusion of cattle, and a program of spruce removal designed to restore the lily habitat. A new colony of western lilies was established on the reserve, isolated from the main population in 1993, which is to date successful. In addition, a seedling bank propagation project was begun in 1993, intended to provide stock for future population expansion projects, or reintroduction projects around Humboldt Bay (Imper and Sawyer, 1994 October, Attachment 1). Current occupied habitat on the reserve is over five acres, primarily spruce forest with inclusions of coastal prairie and coastal scrub. Dominant species include *Picea sitchensis, Calamagrostis nutkaensis, Rubus ursinus* and other species typical of those communities

on the North Coast. Vegetation has changed rapidly in response to removal of cattle and thinning of spruce, primarily evidenced by increase in *Rubus ursinus, Spiraea douglasii* and *Calamagrostis nutkaensis* in the prairie and scrub, and *Erechtites prenanthoides* in the thinned areas.. Although the western lily has responded positively to the manipulation in many areas, severe encroachment by blackberry and scrub in general threatens a portion of the population. In addition, virtually all of the positive response seen in western lily appears to be exhibited by preexisting plants, and there is little evidence that reproduction is occurring. An experimental habitat management project was initiated in 1993, intended to test various methods for maintaining vegetation in a condition suitable for western lily (Imper and Sawyer, 1994 October).

Soils in which the western lily occur often have very low dry bulk density ranging from 60-70 pounds per cubic foot (pcf)(Imper and Sawyer 1994 [October]). Research at the Table Bluff sites suggests an increase in soil density of only 5-10 pcf as a result of past farming was sufficient to make the site unsuitable for the western lily. High sensitivity by the western lily to soil density indicates extreme caution must be taken in habitat restoration activities. Recent thinning of spruce at one site in California caused an increase in soil density of only a few pcf within the vehicle pathway used to access the stand. The change in vegetation and increased soil compaction stemming from that project remained after 4 years.

**Recommendations**. Various recommendations for future conservation and enhancement of the western lily on the reserve and around Humboldt Bay were included in the TBER Management Plan (Imper et al. 1987). A broad scale vegetation control effort is needed within the next year or two to avoid significant impact to the population from encroachment. Fire was to have been included in the methods for experimental habitat manipulation, but has so far been impossible due to the high moisture content of dominant species late in the season. Based on discussions with fire specialists working with the California Department of Forestry and Redwood National Park, it appears that fire may not be a practical method for vegetation management at many western lily sites, at least in California. The current preferred method is strategic re-exposure to cattle on a carefully controlled and monitored seasonal basis. Additional populations should continue to be established in relatively isolated locations on the reserve, as mature seedlings become available from the propagation project. Additional removal of spruce is needed to meet the targets called for in the reserve management plan. Additional research is needed on the adequacy of existing western lily reproduction, and methods for its maintenance.

**Table Bluff -- Johnson Site** (Private, Landowner Contact Program)

This population occurs in a small patch of former pasture, coastal prairie and scrub, dominated by *Calamagrostis nutkaensis, Malus fusca, Carex obnupta, Ledum glandulosum, Rubus ursinus* and introduced pasture grasses. Vegetation changed rapidly after cattle were excluded in 1983, primarily indicated by increase in *Rubus ursinus* and *Calamagrostis nutkaensis*, and decline in various pasture grasses. A seasonal cattle grazing experiment was initiated in 1989, whereby cattle have been allowed in a portion of the habitat between October and March of each year (ongoing). The results of that experiment are so far inconclusive, in part due to the increased impacts from deer in the grazed portion of the habitat. However, the overall population has declined since cattle were excluded, particularly the proportion of young seedlings. Evidence is most strong at this site for cattle involvement in reproduction of western lily, not only related to habitat maintenance and ensuring proper seed bed conditions, but through actual ingestion of western lily seed.

**Recommendations.** If possible, the current cooperative agreement should be amended to include additional management of occupied or suitable habitat immediately adjacent to the exclosure. Protection and proper management of the additional habitat could more than triple the current population. Some form of vegetation control appears needed in the ungrazed portion of the habitat, although population data do not yet show a decline there. Past efforts to coordinate with the California Dept. of Forestry for fire treatment of a portion of the habitat have failed due to the high moisture content of vegetation, and need for excessive starter fuels. Continued attempts at fire application should be made, although it appears fire may not be a practical method for vegetation management at this site.

**Table Bluff -- Barry Site** (Private, Landowner Contact Program)

This site supports a large population dominated by immature plants established in dense spruce forest. The majority of habitat is a matrix of coastal prairie and coastal scrub, dominated by *Calamagrostis nutkaensis, Rubus ursinus, Gaultheria shallon, Ledum glandulosum, Salix hookeriana,* and other species typical of these communities on the North Coast. The habitat is located immediately adjacent to the Humboldt Bay National Wildlife Refuge. Cattle were removed from a portion of the habitat in 1988, and the exclosure was expanded to include virtually all plants in 1993 (Imper 1994b). Vegetation encroached rapidly in response to grazing removal, and seasonal grazing has been conducted since 1993. Other habitat enhancement has included removal of spruce by

the California Conservation Corps, and brush clearing. Grazing by deer and other mammals has been extensive, particularly after periods of vegetation manipulation.

**Recommendations**. Availability of abundant suitable, but unoccupied habitat nearby offers a potential opportunity for significant expansion of the population. If possible, this site and surrounding habitat should be acquired, and preferably added to the wildlife refuge, perhaps with an agreement for the owner to continue cattle grazing. In the alternative, the existing cooperative agreement with the owner should be expanded if possible to include additional habitat and provide for expansion of the current exclosure. If continued monitoring indicates seasonal cattle grazing is insufficient to maintain habitat, manual methods of vegetation control may be necessary. Vegetation at this site may be suitable for burning, due to the relatively dry conditions. If possible, any vegetation manipulation should be conducted over a broader area to diffuse the impacts of deer and other grazing.

**Table Bluff -- Christensen Site** (Private, Landowner Contact Program)

When discovered in 1983, this population exhibited the most numerous and robust flowering plants of any population known throughout the range. The population has since declined steadily until 1994, when only a few flowers were produced ( McRae and Imper 1994). Reasons for the decline are not apparent, but may be directly or indirectly related to cattle exclusion. Monitoring has indicated this is the warmest and driest of the western lily sites on Table Bluff, and presumably in California, related to the south aspect and moderate slope. Habitat is predominately disturbed pasture dominated by introduced grasses, grading to freshwater marsh, coastal prairie and crabapple/willow scrub along the edges. The site was brought into the Landowner Contact Program in 1987, and immediately fenced to exclude cattle which were periodically allowed access late in the season. Vegetation has not shown the rapid successional trends exhibited by other sites after release from cattle, perhaps due to the southern aspect. However, deer grazing has been significant. A deer fence was added in 1993, and small mammal exclosure plots were added in 1994, with limited success. Although not yet confirmed, it appears that removal of cattle may have contributed to drying of the habitat, perhaps in conjunction with the recent drought. Continued impacts of deer and small mammal grazing (voles) combined with poor reproduction and apparent drying of habitat now threaten to extirpate the population. A small number of seed were collected in 1993 for propagation of a seedling bank, to be used for future recovery efforts (Imper and Sawyer 1994 [October]).

**Recommendations**. Immediate efforts are needed in the following areas:

expanded measures to prevent all deer and small mammal grazing; further seed collection if possible during the coming season for inclusion in the artificial propagation project; expanded research on the impact of seasonal cattle grazing on habitat quality and lily reproduction; possible reintroduction of seasonal grazing in a portion of the habitat; out planting of seedlings as soon as they become available from the seedling bank project, both in the current occupied habitat, and adjacent more sheltered habitat. Although fire may be an appropriate and feasible method for habitat manipulation on this site, due to the dry conditions, the risk of extirpation for the western lily is great. Therefore, a carefully planned experimental program should be conducted prior to full scale application.

## Appendix 2: Western Lily Data Sheet and Draft Monitoring Protocol

WESTERN LILY DATA SHEET FORM #2

DATE _____

## PLANT CENSUS

SITE _____ OBSERVER(S)_____

[1] BUD,FLOWER,FRUIT,VEGETATIVE 2 DEFINE MICROHABITAT TYPES AND ABBREV. ON FORM #1

| **(IF SAMPLE GRID EST.)** | | | **(IF SAMPLE** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| REF TRAN | DIST | ADD | **PLOT EST.*)** | PLANT | | PHENOLOGY | | GRAZED/ | #FRUIT |
| Y/X | (X) | (Y) | PLOT# | HT" | FLWR# | (B,FL,FR,V)[1] | HABITAT [2] | DISEASE | Date |
| | | | | | | | | | |

## DRAFT WESTERN LILY RANGE-WIDE MONITORING PROTOCOL: October 1995

**Methods DESCRIPTION**

**1 LANDOWNER COORDINATION:**

Secure landowner permission ; April 1995 issue of Fremontia, based on TNC California Landowner Contact Program is very helpful; make contact at least once per year, before visiting the site; you also may want to send a copy or discuss results after monitoring; in general, involve the owner as much as possible, listen, communicate, adapt as necessary.

**2 PHOTODOCUMENTATION:**

35mm 200asa slide film preferred; establish fixed photopoints with 2' rebar stakes, capped and flagged; map and number locations of rebar stakes for relocation; select points to document important views, such as edge of openings, encroaching willows or shrubs, important concentrations of lilies, etc.; if possible, take two shots of each view; one stake may often be used for four views (e.g., north, south, east, west); record date taken, stake # and direction. You may wish to have prints made to facilitate relocation of the same scene in subsequent years. *TOOLS/MATLS:* rebar 2' stakes and hammer, plastic caps, flagging, compass, camera and 35mm film, map paper, measuring tape

**3 FLOWERING CENSUS:**

The simplest approach is a detailed walk-through of the habitat, recording on datasheet each plant by flower number, height and phenology (bud, flower, fruit - for most mature flower on plant); also note any grazing or other damage to plants, including vegetative plants and other data indicated on form #2; a 4' lathe marked in 6" increments is helpful n spreading vegetation to find plants and measuring. *TOOLS/MATLS:* 4' lathe marked in 6" increments, datasheet.

A preferred method involves some level of mapping of flowering plants, using a sample grid. If a baseline and grid have been established (described below) record X and Y coordinates for each flowering plant, relative to the 0,0 point (Figure 1) In this way, plants may be mapped from year to year enabling assessment of habitat suitability and reproduction. If time is limited, tally groups of plants within grid coordinate ranges (e.g., 9 total flowering plants within X = 10-20, and Y = 0-10; record height, flwr# and phenology of ea. plant). *TOOLS/MATLS:* several 100' measuring tapes, 25' pocket tape or loggers tape, lathe.

The above methods are suitable for tracking changes in spatial distribution of lilies as a result of vegetation encroachment or other factor; the resolution is not ideal for tracking individuals from year to year, especially in concentrated areas. Mapping designed to track individual life history generally will require greater resolution, provided by mapping within fixed plots or placing aluminum tags next to each plant at consistent orientation and distance.

**4 VEGETATIVE PLANT CENSUS:**

An option for small sites or where sufficient volunteer effort is available is to conduct a complete census. All plants are recorded, enabling assessment of recruitment and other population analysis. Methods are identical to flowering census; data includes evidence of disease or herbivory .

**5 BASELINE AND GRID LAYOUT:**

The mechanics of laying out a sample grid will vary according to site; however, each site should have a baseline established in an easily located area, from which lateral gridlines are extended. An example is shown in Figure 1, in which the baseline is located in the middle of the population, dividing habitat into a "+" and "-" side for the purpose of inventory and mapping. The baseline is marked with 2' capped rebar stakes at 100' intervals, so that a 100' rollup tape may be stretched tight between stakes. Tape measures may then be stretched out on each

side from the baseline at fixed intervals (10' spacing works well for plant inventory). Endpoints of the lateral lines are marked at convenient locations with rebar. Assuming the baseline is assigned Y = 0 coordinate, locations of plants are recorded as distance away

**Appendix 3: Summary of the Agency and Public Comment on the Draft Western Lily Recovery Plan.**

In September 1997, the Service released the draft recovery plan for the western lily for a 60 day comment period, ending on November 4, 1997 (62 FR 48345). Over 57 copies of the draft plan were sent out for review in addition to the 50 agencies or elected public officials that were notified.

Only four letters/comments were received and only one substantive issue provided beyond several clerical comments relating to wording or clarity. Two comments were from the authors, a third was from a private land owner who owns one of the populations, and the fourth was from California Department of Fish and Game. All of these comments were incorporated into the final plan. The single substantive issue is with respect to the geographic distribution of populations needed for recovery. Populations need to be spread over the entire range of the species, in all the recovery zones. One of the recovery zones is not presently known to have a population, so if populations are found there, they will be quite important.

The following is a list of those Agencies and Individuals being notified or receiving a copy of the plan for review. Those with an * received a copy of the plan and those with a ∫ provided comments.

Elected Officials

Congressman Frank Riggs, 710 E Street, Eureka, California 95501.

Congresswoman Elizabeth Furse - District 1, 2701 NW Vaughn Suite 860, Portland, Oregon 97210.

Congressman Robert Smith - District 2, 843 E. Main Street Suite 400, Medford, Oregon 97504

Congressman Earl Blumenauer - District 3, 516 SE Morrison, Suite 250, Portland, Oregon 97214.

Congressman Peter DeFazio - District 4, 151 W 7th Ave. Suite 400, Eugene, Oregon 97401

Congresswoman Darlene Hooley - District 5, 315 Mission St. SE Suite 101, Salem, Oregon 97302

Governor Pete Wilson, State Capitol, Sacramento, California 95814.

Governor John Kitzhaber, State Capitol, Salem, Oregon 97310.

Senator Barbara Boxer 1700 Montgomery Street #240, San Francisco, California 94111.

Senator Dianne Feinstein, 525 Market Street #3670, San Francisco, California 94105.

Senator Gordon Smith, World Trade Center, 121 SW Salmon, Portland, Oregon 97204.

Senator Ron Wyden, 151 W 7th Ave., Suite 435, Eugene, Oregon 97401

State Representative Mike Lehman - District 47, 320 Central Ave., Suite 512, Coos Bay, Oregon 97420.

*State Representative Ken Messerle - District 48, 1740 Coos City-Sumner Road, Coos Bay, Oregon 97420.

State Senator Mike Thompson, 317 Third Street Suite 6, Eureka, California.

State Senator Veral Tarno - District 24, P.O. Box 657, Coquille, Oregon 97423.

Mayor City of Arcata, 736 F Street, Arcata, California 95521.

Mayor Judy Densmore for City of Bandon, 555 U.S. Highway 101, Bandon, Oregon 97411.

Charlie Williams for City of Bandon, P.O. Box 67, Bandon, Oregon 97411.

Mayor City of Brookings, 898 Elk, Brookings, Oregon 97415.

*City Manager Tom Weldon for Brookings, 898 Elk Drive, Brookings, Oregon 97145.

Mayor Joanne Verger for Coos Bay, 500 Central Ave., Coos Bay, Oregon 97420-1895.

City Manager for Crescent City, 377 J Street, Crescent City, California 95531.

Mayor Nancy Flemming, City of Eureka, City Hall, 531 K Street, Eureka, California 95501.

Commissioner Beverly Owen, Coos County, 250 N Baxter, Coquille, Oregon 97423.

Commissioner Lloyd H. Olds, Curry County, P.O. Box 746, Gold Beach, Oregon 97444.

Board of Supervisors for Del Norte County, 583 G Street, Crescent City, California 95531.

* Diane Mutchie Senor Planner Delnorte County, 700 5th Street, Crescent City, California 95531.

Board of Supervisors for Humboldt County, 825 Fifth Street, Eureka, California 95501.

Media

Susan Bailey KATY 50 News, 533 Mendocino Avenue, P.O. Box 1150, Santa Rosa, California 95402.

Federal Agencies

*Karen Colbank, U.S. Army Corps of Engineers, Environmental Resources Branch, Atten. Robert Willis, 333 SW 1st Avenue, Portland, Oregon 97208.

* John Willoughby, Botanist, Bureau of Land Management, 2800 Cottage Way, Sacramento, California 95825-1889.

District Manager Edward Shepard, Bureau of Land Management - Coos Bay District, 1300 Airport Lane North Bend, Oregon 97459.

* Bruce Rittenhouse, Bureau of Land Management - Coos Bay Office, 1300 Airport Lane North Bend, Oregon 97459.

* National Botanist Ken Berg, Bureau of Land Management, Division of Wildlife and Fisheries, 1849 C street, NW, Washington D.C. 20240.

* Botanist Cheryl A. McCaffrey, Bureau of Land Management - Oregon State Office, 1515 S.W. 5th Avenue, P.O. Box 2965, Portland, Oregon 97208.

* Joel Shaich, Environmental Protection Agency, 811 SW 6th Avenue, 3rd floor, Portland, Oregon 97204.

* Mary Blevins, Environmental Protection Agency – San Francisco, 75 Hawthorne Street, mail code WST4, San Francisco, California 94105.

* Director Leon Whitman, Federal Highway Administration, 222 SW Columbia Suite 600, Portland, Oregon 97201.

* Endangered Plant Coordinator Peggy Olwell, National Park Service, Wildlife and Vegetation Division, P.O. Box 37127, Washington, DC. 20013-7127.

* State Conservationist Bob Graham, Natural Resource Conservation Service, 101 SW Main Street Suite 1300, Portland, Oregon 97204.

* State Biologist Bianca Streif, Natural Resources conservation Service, 101 SW Main Street, Suite 1300, Portland, Oregon 97204.

* Chris Nagano, U.S. Fish & Wildlife Service, Carlsbad Field Office, 2730 Loker Avenue West, Carlsbad, California 92008

* Gary Wallace, U.S. Fish & Wildlife Service, Carlsbad Field Office, 2730 Loker Avenue West, Carlsbad, California 92008.

* Monty Knudsen U.S. Fish & Wildlife Service, Office of Technical Support, 333 SW 1st Avenue, Box 3623, Portland, Oregon 97208.

* Jan Knight, U.S. Fish & Wildlife Service, Sacramento Field Office, 3310 El Camino Avenue, Sacramento, California 95825

*Refuge Manager Jim Houck, U.S. Fish & Wildlife Service, Western Oregon Refuge Complex, 26208 Finley Refuge Road, Corvallis, Oregon 97333-9533.

*Dr Mark Skinner, USDA National Plant Data Center, Box 74490, Baton Rouge, Louisiana 70874.

State Agencies

*Rick Marovich, DPR, 1020 N Street, Room 332, Sacramento, California 95814.

Mr. Craig Martz, California Department of Fish and Game, 601 Locust Street, Redding, California 96001.

*Ken Moore, California Department of Fish and Game, 619 2nd Street, Eureka, California 95501.

*Dr. Oren Pollock, California Department of Fish and Game - Natural Heritage Division, 1220 S Street, Sacramento, California 95814

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*Ken Anderson, California State Parks, 600 A.W. Clark Street, Eureka, California 95501.

*Robert Meinke, Oregon Department of Agriculture, 635 Capitol Street NE, Salem, Oregon 97310-0110

Director Jim Greer, Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, Oregon 97207.

*Master Planning and Heritage Assessment Coordinator Kathy Schutt, Oregon Department of Parks and Recreation, 1115 Commercial Street NE, Salem, Oregon 97310-1001.

*Andy LaTomme, Oregon Department of Parks and Recreation -Operation Division Area 4 South Coast, 10965 Cape Arago Hwy., Coos Bay, Oregon 97420-9647.

*Nick Testa, Oregon Department of Transportation - Technical Service Branch, 1158 Chemeketa Street NE, Salem, Oregon 97310

Academic Organizations & Societies

*Kara Wippstock, Colorado State University - Documents Department, Libraries, Fort Collins, Colorado 80523-1019.

*Dr. John Sawyer, Humboldt State University - Biology Department, Arcata, California 95521.

*Dr. Bruce Pavlik, Mills College, 5000 MacArthur Boulevard, Oakland, California 94613.

*Jeff Goddard, Oregon Institute of Marine Biology, Charleston, Oregon 97420.

Director Mike Graybill, South Slough National Estuarine Research Reserve, P.O. Box 5417, Charleston, Oregon 97420.

*Dr. Stewart T. Schultz, University of Miami - Biology Department, Coral Gables, Florida 33124.

*Dr. Doug Schemske, University of Washington - Botany Department, Seattle, Washington 98195.

President Barbara Hill, The Wildlife Society - Oregon Chapter, Bureau of Land Management, P.O. Box 2965, Portland, Oregon 97208.

Conservation Organizations

1000 Friends of Oregon, 534 SW Third, Portland, Oregon 97204.

∫Dr. Ed Guerrant, Berry Botanic Garden, 11505 SW Summerville Ave., Portland, Oregon 97219.

*David Tibor, California Native Plant Society, 1722 J Street Suite 17, Sacramento, California 95814.

California Native Plant Society - Dorothy King Young Chapter, P.O. Box 985, Point Arena, California 95468.

California Native Plant Society - North Coast Chapter, P.O. Box 1067, Arcata, California 95521.

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Ray Nolan, National Audubon Society- Cape Arago, 1890 Waite Street, North Bend, Oregon 97459.

National Audubon Society - National Office, 700 Broadway, New York, New York 10003-9501.

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National Audubon Society - Redwood Region, P.O. Box 1054, Eureka, California 95501.

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* Kate Dwire, Native Plant Society of Oregon - State Committee, West Side Conservation, 429 SW 10th Street, Corvallis, Oregon 97333.

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Oregon Environmental Council, 520 SW Sixth Ave., Suite 940, Portland, Oregon 97204.

Executive Director Marc Smiley, Oregon Natural Resources Council, 5825 N. Greeley Avenue, Portland, Oregon 97205.

Susie Van Kirk, Sierra Club - Arcata Group, P.O. Box 238, Arcata, California 95521.

Sierra Club - Northwest Office, 1516 Melrose Avenue, Seattle, Washington 98122.

Sierra Club - Oregon Chapter, 3701 SE Milwaukie Ave., Suite F, Portland, Oregon 97202.

* Dan Salzer, The Nature Conservancy- Oregon Field Office, 821 SE 14th Avenue, Portland, Oregon

* James Kagan, The Nature Conservancy- Oregon Natural Heritage Program, 821 SE 14th Avenue, Portland, Oregon

Darren Borgas, The Nature Conservancy - Southwest Oregon Office, 43 Third Street, Ashland, Oregon 97520.

Industrial Organizations

Cattleman's Association, 1200 NW Front Ave., Suite 290, Portland, Oregon 97209.

* Robert E. Preston, Jones & Stokes Associates, Inc., 2600 V Street Suite 100, Sacramento, California 95818-1914.

* Rick Spaulding, Ogden Environmental, 1 East Antipuma Street, Santa Barbara, California 93101.

* Richard Podriznik, Perkins COIE, 1201 Third Avenue, 40th floor, Seattle, Washington 98101-3099.

* Stephen Westbrook, Reservation Ranch, P.O. Box 75, Smith River, California 95567.

* Fred Jackson, Tetra Tech, 5203 Leesburg Pike, Suite 900, Falls Church, Virginia 22041.

Interested Parties

* Stephanie Buffum, P.O. Box 710, Tucson, Arizona 85702

* Rick Burbach, Rt 1., Box 1480, Bandon, Oregon 97411.

* Stuart Garbutt, P.O. Box 660, Ferndale, California 95536.

∫ David K. Imper, 4612 Lentell, Eureka, California 95503

* John McRae, 2525 Daffodil Avenue, McKinleyville, California 95519.

* Boot Robie, 37748 Quarter Way, Arcata, California 95521.

* William B. Strickland, 3125 Lowell Street, Eureka, California 95501.

* Virginia Strom-Martin, 510 O Street #G, Eureka, California 95501.

Private Land Owners

∫ Carl & Alberta Johnson, 3045 Table Bluff Road, Loleta, California 95551

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**U.S. Fish and Wildlife Service**
**Ecological Services**
**911 N.E. 11th Avenue**
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